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SOUND RANGING EFFECTIVENESS MODEL (SREM).(U)
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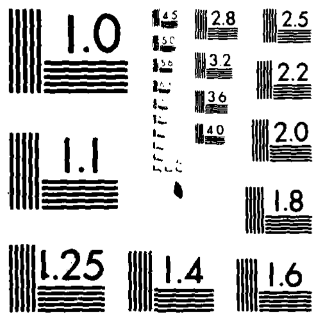

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The Sound Ranging Effectiveness Model (SREM) was developed in order to examine the loading effects of different firing rates on present sound ranging systems as well as to help establish criteria for future system requirements. The model uses artillery missions generated in a division level wargame (DIVLEV) to simulate the associated sounds and the times they reach the sound base as well as their relative intensities. Performance estimates for various sound ranging capabilities, based on 3 1/2 hours day and 3 1/2 hours night combat simulation are given

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SOUND RANGING EFFECTIVENESS MODEL (SREM)

1. INTRODUCTION

Recently, there has been a resurgence of interest in sound ranging as a target acquisition system. This resurgence of interest may be attributed to several factors:

(a) Cost -- when compared to other target acquisition systems sound ranging is relatively inexpensive.

(b) Detectability -- while radars must transmit intermittently and move periodically to avoid detection, a sound base is passive and may remain operative continuously.

(c) Commonality -- presently, sound ranging is the most common system for locating hostile indirect fire weapons among the NATO countries.

(d) Historical success -- during both World War II and the Korean War, sound ranging was the most productive target acquisition system available.

In support of this increased interest, AMSAA has developed a sound ranging effectiveness model (SREM). This model, which is keyed to a two-sided division level wargame, was developed to examine the loading effects of different firing rates on present manual sound ranging systems, as well as to help establish criteria for future system requirements.

The model uses artillery missions generated in the division level wargame to simulate the associated sounds and the times they reach the sound base as well as their relative intensities.

Performance estimates for various sound ranging capabilities, based on 3 1/2 hour-day and 3 1/2-hour night combat simulation, are given. Results show that although sound ranging will often be saturated at the high firing rates associated with an intense break-through scenario, there are still many opportunities to locate hostile indirect fire positions.

Appendix A contains a User's Guide on how to set up an input file and run the program. Appendix B contains a listing of SREM along with sample inputs and sample outputs.

2. BACKGROUND

The French initiated experiments in sound ranging in September 1914. These experiments led to the organization of sound ranging sections within the French Army and subsequently, sound ranging sections were rapidly adopted by all of the Allies.

By 1934, the first US observation battalion, under the Field Artillery, was activated. Improvements made at this time included modifications to permit the use of standard field wire, more sensitive microphones, improved designs of recording instruments, more accurate plotting equipment, and adaptation of procedures to improve tactics.

During World War II, the US sound ranging community was expanded to 25 full observation battalions for approximately 75 percent of all confirmed targets located during World War II.

By 1950, when the Korean War started, the 1st Observation Battalion was the only organization of its kind in the US Army, and it was only at 60 percent full strength. By the end of the Korean conflict, there were four observation battalions, two of which were in Korea. During the Korean War, sound ranging, on the average, located 4 percent of all active batteries on a given day, this represented 59 percent of all locations made.

In Vietnam, due to the long emplacement time and the large amounts of wire necessary, sound bases were deployed only along the DMZ, but due to the poor condition of the equipment (the equipment was World War II vintage) and the lack of experience of the operators, sound ranging was deemed to be of little use.

Figure 1 illustrates the typical deployment of a sound base. The sound observers, labeled O.P. initiate a paper tape strip recorder, which is located at the command post, when they detect incoming sounds. The paper tape records the low frequency responses of the six microphones on six separate channels as typified in Figure 2. A three foot strip of tape, corresponding to about six seconds, is activated by the sound observer. The command post crew would then try to correlate the six breaks, one on each channel, which resulted from the same sound source. By determining the differences in times of arrival for any two channels, a bearing to the sound source can be manually plotted. When the five independent bearings all intersect closely, the weapon location has been determined. Figure 3 demonstrates which of the sound "breaks" in Figure 2 could be correlated to give sound locations. Table 1 lists the basic characteristics of the current US sound ranging system. Near-term improvements to this system include replacement of wire by radio data links and a computer and CRT to assist in plotting the sound locations.

Although Figure 2 depicts a strip of tape with a relatively low rate of sound events, about 25 sound events per minute, one can see that the art of reading and correlating the breaks requires a high level of skill and proficiency. In particular, it has long been known that high rates of fire can completely saturate a reader's ability to resolve any targets on a tape in a timely manner.

To date, no study has been found which addresses the loading problems a sound ranging system will face in a mid-to-high-intensity scenario. The sound ranging effectiveness model was developed in order to determine how often a sound ranging system will be saturated, and what target producing capabilities it will have in such a scenario.

3. SREM DESCRIPTION

Figure 4 shows the basic flow diagram for the sound ranging effectiveness model (SREM).

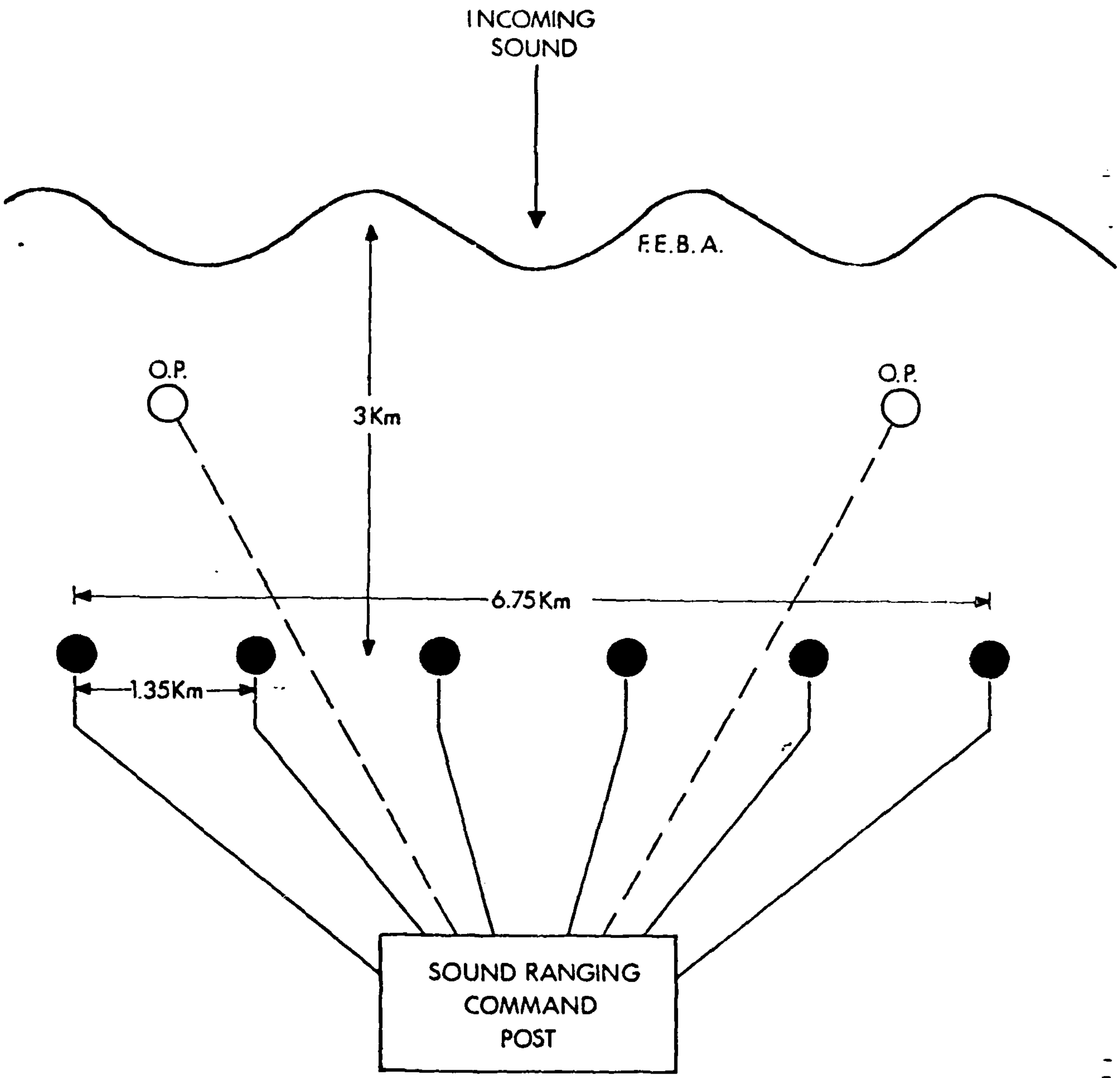

FIGURE 1. SOUND BASE DEPLOYMENT SCHEMATIC

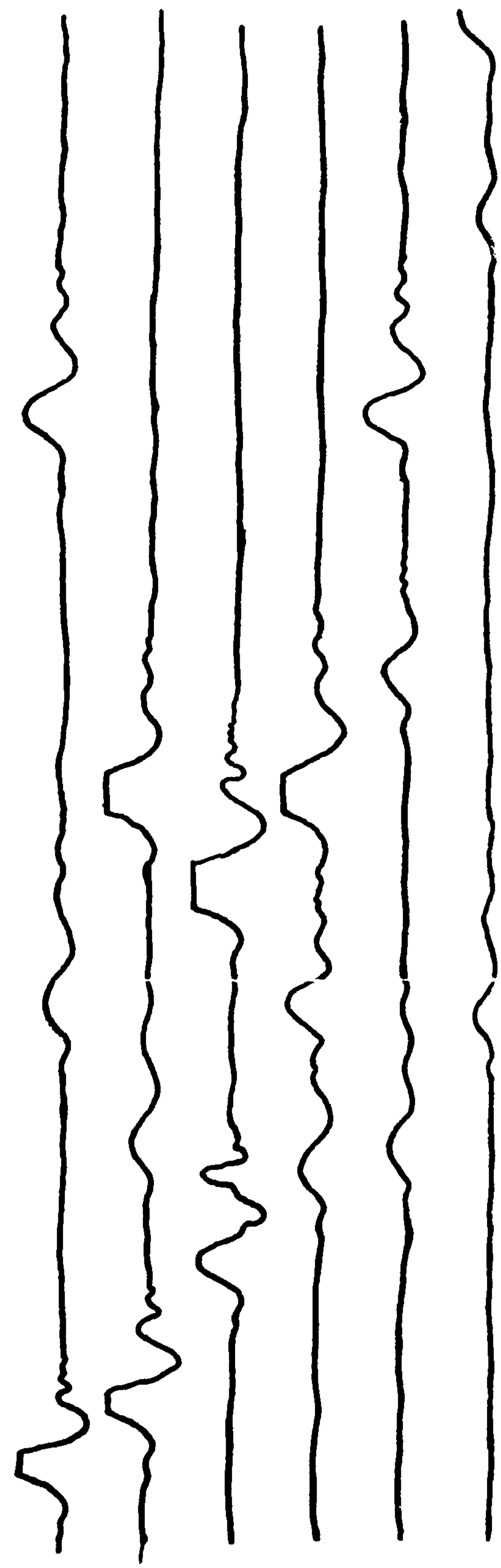

FIGURE 2. TYPICAL SOUND BREAKS ON A PAPER TAPE FOR A LOW RATE OF FIRE

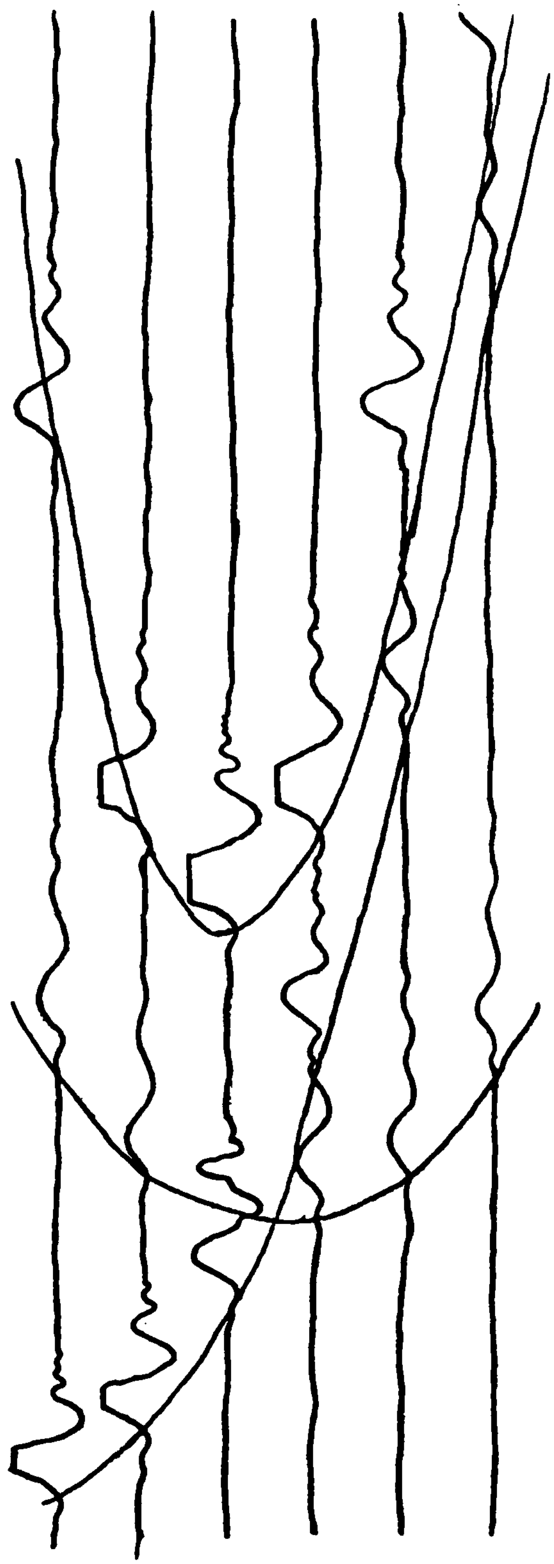

FIGURE 3. CORRELATION OF SOUND BREAKS

TABLE 1. SOUND RANGING SET AN/TNS-10 CHARACTERISTICS

AN/TNS-10 IS A PRODUCT IMPROVED AN/GR-8 (FULLY TRANSISTORIZED)

NUMBER OF RECORDING CHANNELS	-	6
METHOD OF RECORDING	-	DRY, ELECTROSTATIC
RECORD MEDIUM	-	TELEDELTOS PAPER
CHART SPEED	-	6 INCHES/SECOND
TIMING MARKS	-	0.01, 0.1, 1.0 SECOND
DIGITAL TIME PRINTOUT	-	1-SECOND INTERVALS
POWER REQUIREMENTS	-	STANDBY: 12 VOLTS; 125 MA OPERATING: 12 VOLTS; 7.5 AMP
SIZE	-	TRANSIT CASE: 13.5" x 16.5" x 26.5"
	-	OPERATIONAL: 12.4" x 21.9" x 10.3"
WEIGHT (INCLUDING TRANSIT CASE)	-	100 LBS

SOUND RANGING EFFECTIVENESS MODEL

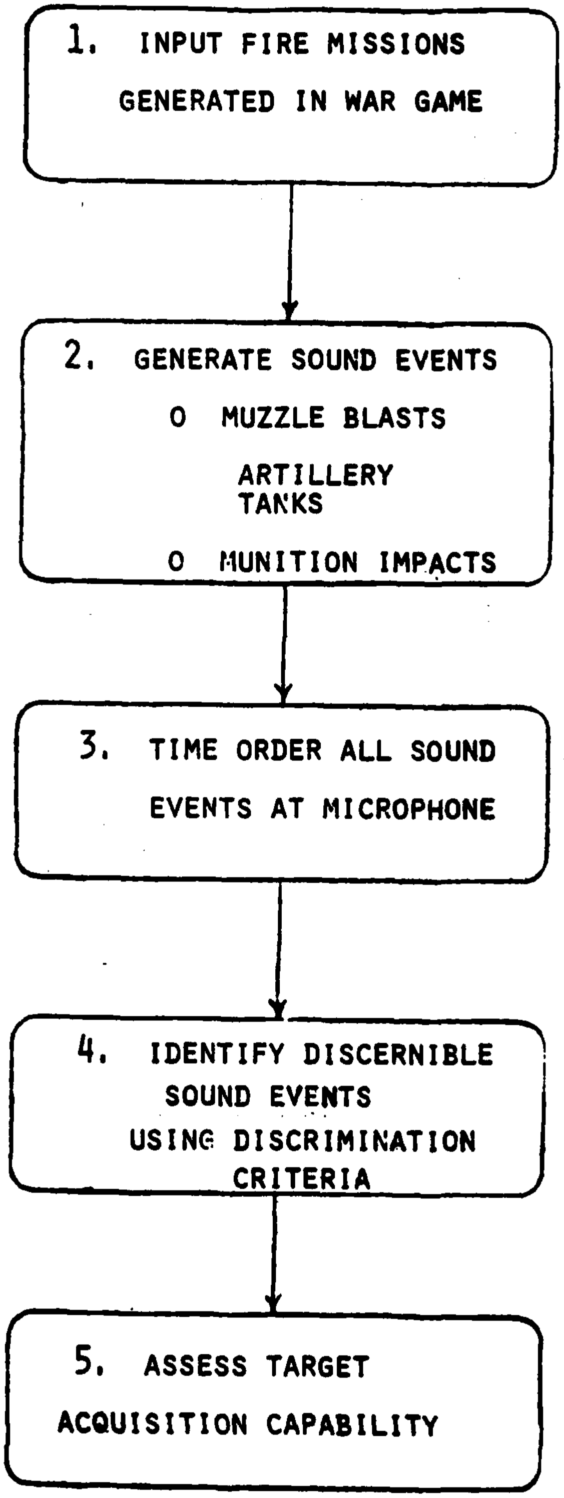

FIGURE 4 BASIC FLOW DIAGRAM

Step 1 -- missions are generated by a two-sided division level wargame (DIVLEV) for both Red and Blue direct and indirect fire units as well as air support. These missions are then used as inputs to SREM.

Step 2 -- sound events are generated for the following battlefield events:

muzzle blasts from - mortars
cannons
rockets
tank guns

impact blasts from - mortars
cannons
rockets
anti-tank guided missiles (ATGM)
air-to-ground missiles, bombs

Step 3 -- the sound events are ordered by their arrival times at a sound ranging microphone.

Step 4 -- the loading effects on the sound ranging system are assessed and discernible sound events are identified based on the sound ranging system parameters being modeled.
Step 5 -- discernible sound events are examined to determine which events represent hostile artillery targets which could be reported.

3.1 <u>SREM Inputs</u>.

Whenever an indirect fire mission is generated in the wargame, the following information is written to an output file:

- time of the mission
duration of the mission
weapon location
target location
weapon type
number of weapons in the firing battery

When an engagement of direct fire weapons is generated in the wargame, the following information is written to the output file:

- time of engagement
duration of the engagement
weapon location
weapon type
number of rounds fired per minute

When an air support mission is generated by the wargame the following is written to the output file:

- time the ordnance was delivered
location of the target

type of ordnance delivered
amount of ordnance delivered

This output file which is generated by the wargame is then used as the input file for SREM.

3.2 Generation of Sound Event Times.

Sound event times are generated based on the times that sounds would arrive at the sound ranging microphone. Initial times for each sound event, that is, the time the sound events were created, are based on the mission start time (from the input file), and the sustained rate of fire for that weapon. Initial times for impacts are based on the firing time for the weapon involved and the flight time of the projectile (which is dependent on the weapon-to-target distance).

Once an initial time for a sound event is determined, the time required for the sound to propagate to the sound ranging microphone must be calculated. The propagation time in SREM is calculated using a constant speed of sound (assuming a homogeneous standard atmosphere) over the distance from the sound event to the microphone.[1]

3.2.1 Indirect Fire Times. At the start of each indirect fire mission, the initial firing time for each weapon is distributed normally about the mission start time in order to simulate crew reaction time. Subsequent firing times for each weapon are based on a normal distribution about the mean firing rate for that weapon. Table 2 gives the standard rates of fire for the various indirect fire weapons which were played. A standard deviation of one tenth the time between firings was used, and a minimum firing time of one third the standard time between rounds was imposed. Firing times for each weapon in that battery continue to be generated for the entire length of the mission.

3.2.2 Direct Fire Times. For direct fire engagements, the initial firing times and the subsequent firing times are calculated using the same rules used for direct fire missions. However, the rate of fire for these engagements is determined by the number of rounds fired by that unit in that minute; this is obtained from the input file. Two engagements of the same unit, therefore, will not necessarily have the same rate of fire. The number of rounds fired is dependent on the individual engagement and is determined by the wargame. For direct fire missions consisting of tanks and anti-tank guided missiles (ATGM) only the muzzle blast from the tank main armament, and only the impact sound from an ATGM are considered as sound sources which would register on the sound ranging microphone. The impact from a tank round and the launch of an ATGM are mostly high frequency sound events which tend to be discriminated out at the microphone.

[1] The reader is reminded that the purpose of SREM is to investigate only the loading effects on sound ranging systems; the details of sound propagation through moving and inhomogeneous atmospheres, although required for accuracy calculation, is not warranted by the one second time resolution of SREM.

TABLE 2. SUSTAINED RATES OF FIRE

WEAPON	ROUNDS/MIN
155 MM HOWITZER	1.0
8 INCH	.5
81 MM MORTAR	8
4.2 INCH MORTAR	3
120 MM MORTAR	3
152 MM GUN/HOWITZER	1
122 MM MULTIPLE RAIL LAUNCHER	40
130 MM GUN	1
122 MM HOWITZER	1.5

3.2.3 Air Support Times. Air support missions have the number and type of ordnance to be delivered specified. The ordnance is delivered uniformly over the time period indicated by the mission duration time.

3.3 Generation of Sound Intensities.

The firing charge used for each mission is determined by first computing the range to the target; then from the weapon firing tables one of the top three charges available for firing that range is selected randomly. The peak over pressure detected at the sound ranging microphone is calculated using the equation:

$$P = 210(W^{1/3}/R)^{1.047}$$

where P = pressure in pounds per square inch,
W = equivalent charge weight in pounds of TNT, and
R = range in feet from the sound source to the microphone.

This equation was developed by curve fitting to data collected by the Ballistic Research Laboratories (BRL) and reported in BRL Report #1240. SREM converts this pressure to amplitude in db for printout and storage. Table 3 shows the TNT charges used for approximating both muzzle and impact blasts. The charges are those used for the various missions fired in the wargame. The equivalent TNT charge weights have already been taken to the 1/3 power as used in the propagation formula. It should be noted that these equivalent TNT charges are matched to far field peak overpressures and are not intended to reflect the destructive force from the actual muzzle or impact blast.

3.4 SREM Bookkeeping.

Sound events are grouped by amplitude and then ordered based on their arrival times at the sound ranging microphone. Figure 5 is a sample output available from SREM. "MIN" is the minute of the wargame being displayed. "SEC" is the second in the minute under consideration. "TOT" is the total number of sound events in that second which could be detected. The numbers across the top indicate the amplitudes at which the sounds arrived. Sounds arriving below 70db in amplitude were considered too low to be detected and were, therefore, not included in the total. The numbers to the right of the slash indicate how many of the total number of sound events are Red indirect fire muzzle events.

One of the purposes of this model, given the loading effects of a scenario, is to evaluate parametrically the target production potential of sound systems based on the capability to discern sound sources whose sounds overlap in time at the various microphones in the sound base. Therefore, an input parameter was included which allows the user to arbitrarily define when a sound ranging system is no longer capable of discerning targets due to saturation. As the rate of sound events reaching the sound ranging microphone increases, the capability of the system to discern targets initially increases proportionally then levels off and finally decreases due to both the overlapping of arriving sound signatures and the increased difficulty in associating which of the several sound breaks on each channel corresponds to the same source. Within the expected area of coverage of a

TABLE 3. EQUIVALENT BARE TNT CHARGES USED TO SIMULATE INITIAL SOUND INTENSITIES

WEAPON TYPE	CHARGE	EQUIVALENT TNT CHARGE $W^{1/3}$ (IN $LBS^{1/3}$)	EQUIVALENT TNT CHARGE USED FOR DETONATION OF HE ROUND (IN $LBS^{1/3}$)
155mm howitzer	3w	1.46	2.605
	4w	1.59	
	5w	1.90	
	6w	2.13	
	7w	3.04	
8 inch howitzer	1	1.63	3.311
	2	1.87	
	4	2.34	
	5	2.50	
	6	2.81	
	7	3.04	
81mm mortar	6	.524	1.341
	7	.555	
	9	.617	
4.2 inch mortar	19	.745	1.983
	20	.763	
	25	.839	
	39	.921	
	40	.927	
120mm mortar	1	.355	1.728
	2	.427	
	3	.479	
	4	.530	
	5	.575	
	6	.618	
122mm howitzer	4	.538	2.089
	3	1.37	
	2	1.67	
	1	2.02	
	Partial	2.34	
	Full	2.82	
152mm howitzer	12	1.48	1.934
	10	1.68	
	8	1.90	
	5	2.28	
	3	2.50	
	1	2.56	
	Full	2.63	

TABLE 3. CONTINUED

WEAPON TYPE	CHARGE	EQUIVALENT TNT CHARGE $W^{1/3}$ (IN LBS$^{1/3}$)	EQUIVALENT TNT CHARGE USED FOR DETONATION OF HE ROUND (IN LBS $^{1/3}$)
122mm MRL		.073	2.089
130mm gun	4	.186	2.089
	3	.280	
	2	.401	
	1	.629	
	Full	1.05	
125mm tank gun		2.50	
175mm gun	1	2.90	3.288
	2	3.43	
	3	3.95	
105mm tank gun		2.29	
CBU-24			4.54
Rockeye			4.10
Maverick			3.50
RBK-500			4.54
RBK-250			4.10
500 lb bomb			5.76

MIN = 0713

AMPLITUDE IN DB

SEC	TOT	> 110	105-110	100-105	95-100	92-95	89-92	87-89	84-87	80-84	70-80	< 70
1	2	/	/	1/	/	/	/	/	/	/	1/ 1	10/10
2	2	/	/	/	/	/	/	/	/	1/ 1	1/ 1	/
3	5	/	1/	/	1/	/	/	/	1/ 1	/	2/ 2	/
4	12	/	2/	/	4/	/	/	/	3/ 2	2/ 1	1/	/
5	3	/	1/	/	/	/	/	/	/	/	2/ 2	8/ 8
6	3	/	1/	/	/	/	/	/	/	1/ 1	1/ 1	/
7	4	/	1/	/	/	/	/	/	/	/	3/ 3	7/ 6
8	4	/	1/	/	/	/	1/	/	1/	/	1/ 1	/
9	2	/	/	1/	/	/	/	/	/	/	1/ 1	/
10	4	/	/	/	2/	/	/	/	2/ 1	/	/	/
11	1	/	/	/	/	/	/	/	/	/	1/ 1	/
12	3	1/	/	/	/	/	/	/	/	1/ 1	1/ 1	/
13		/	/	/	/	/	/	/	/	/	/	6/ 6
14		/	/	/	/	/	/	/	/	/	/	5/ 4
15		/	/	/	/	/	/	/	/	/	/	/
16	4	1/	/	1/	/	/	/	/	/	1/ 1	1/ 1	/
17	4	1/	/	/	1/	/	/	/	1/	1/ 1	/	/
18	5	/	1/	/	1/	/	/	/	/	/	3/ 2	/
19		/	/	/	/	/	/	/	/	/	/	/
20	3	/	1/	1/	/	/	/	/	/	1/ 1	/	/

FIGURE 5 . SAMPLE SREM OUTPUT

linear sound base (In a linear sound base the microphone are placed 1 sound sec apart), the arrival times at six microphones from a single sound source will usually occur within 6 seconds. This input parameter, therefore, is defined in terms of the number of sound events arriving in a 6-second window at a single point. The point chosen for measuring the number of sound events should represent the center of the sound base deployed. In this way sound events have already traversed three microphones by the time the model detects them. A location can be made wih information from 3 channels (accuracy improves with additional information from other channels). Therefore, using a six second window insures that a sound event has or will have traversed at least three sound ranging microphones during that 6 second period and that a location can be determined for each sound event detected in a six second window where the CT has not been execeeded.

This input parameter, which we call the critical threshold (CT), is defined as the maximum number of sound events that may occur during a 6-second period in which it is still possible to discern targets. By varying the critical threshold, various sound ranging capabilities can be modeled. The user should take care to identify all the variables which will reduce the point at which a particular system will saturate (the CT), since the results obtained are very dependent on this parameter.

Once all the sound events are generated, the output is scanned with a 6-second window. If the total number of sound events in the window is less than CT then all the Red muzzle events in that 6-second window are counted as discernible. The number of discernible Red muzzle events in that window is then used to increment how often that number of targets could be detected at the current rate of fire. The Combat Surveillance and Target Acquisition Lab at Ft. Monmouth, NJ performed an analysis on the capabilities of sound ranging; part of their results are summarized in Figure 6.

Figure 6[1] represents the resolvable combinations per minute for a given number of arrivals per minute. This would represent the limiting capabilities of a completely automated system in a steady state condition. This also represents the physical limitations on sound ranging. For example, the curve labeled "5 of 6" is the theoretical limit, assuming that the interarrival times on each channel are distributed exponentially and independently, that at least five out of six channels will have sound breaks which do not overlap any of the other breaks on each of those channels. Another way of understanding the curves displayed in Figure 6 is to assume a limiting capability on a particular system. For example, if a system had 6 channels and required unmasked sound breaks on at least 4 channels then the curve "$\leq$ 4 of 6" would represent its capabilities, however, if that same system required unmasked sound breaks on at least 5 channels then its capability would be reduced to that labeled "$\leq$ 5 of 6." This figure also demonstrates that if you have a large number of microphones, then the probability of having unmasked sound breaks on at least 5 channels is much higher, which is only logical. It is noted that the abscissa for these

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[1] Figure 6 was provided by the Combat Surveillance and Target Acquisition Laboratory, Fort Monmouth, NJ.

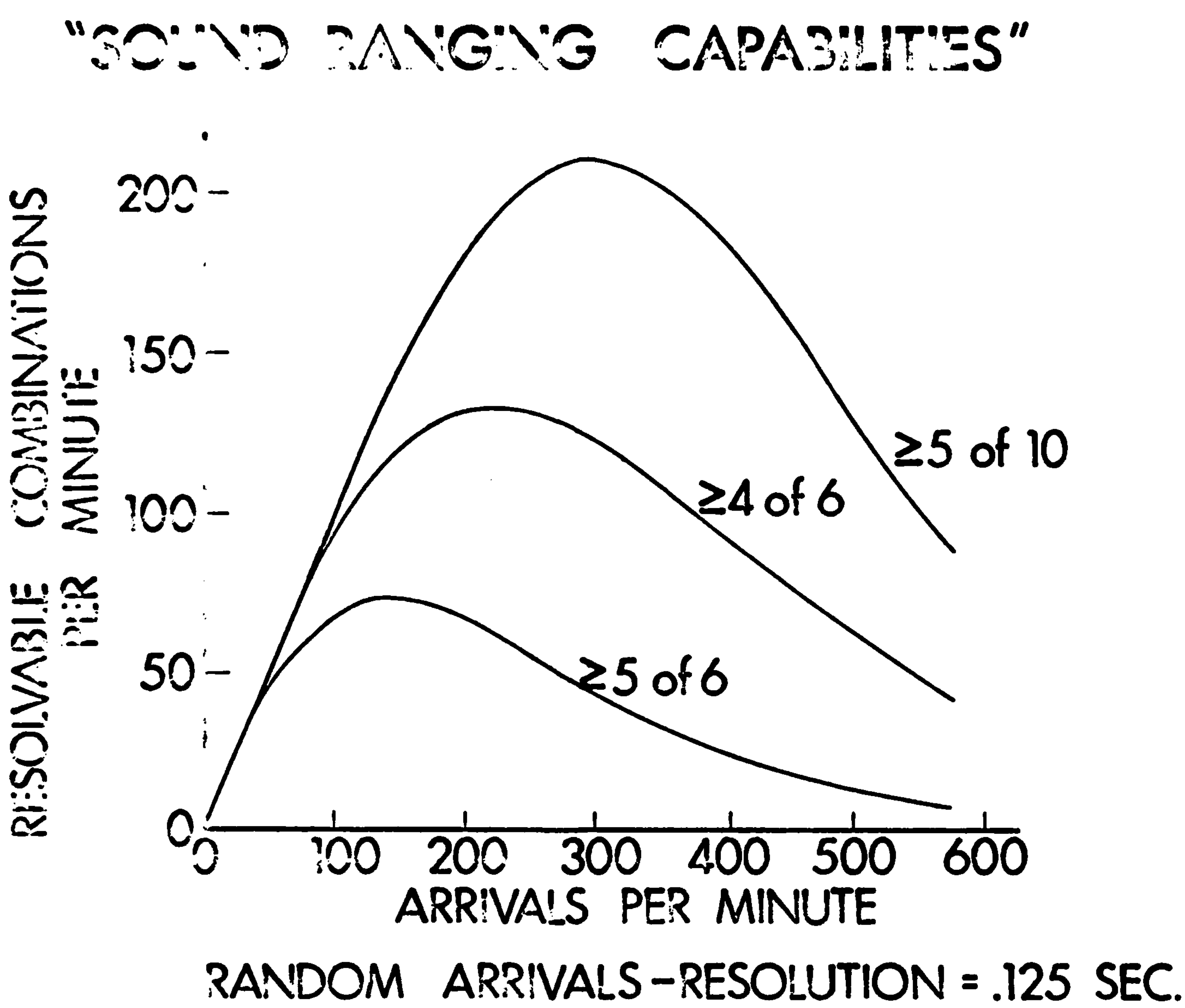

FIGURE 6. SOUND RANGING CAPABILITIES (Figure provided by Combat Surveillance and Target Acquisition Laboratory, Ft. Monmouth, NJ)

curves is the average number of sound events arriving per minute - not the rate of fire - and that the ordinate shows how many of these events could be resolved.

3.5 Outputs.

SREM provides the user with:

- a time history of when and how many targets were acquired as well as the number of these that would be unique targets

- percent of game time a sound ranging system would be able to locate 1,2,3,..... etc. Red muzzle events for all rates of fire in the game

- based on results obtained at the different rates of fire, SREM computes what percent of game time a sound ranging system would be able to locate 1,2,3,...... etc. Red muzzle events assuming the rate of fire was held constant

- percent of game time for each rate of fire

3.6 Sample Results.

For the purposes of this analysis, it was assumed that a critical threshold (CT) of 6 was equivalent to the capabilities of a present day manual system comparable to that of an AN/TNS-10. A CT of 12 was assumed to be equal to the capabilities of an achievable, automated system. The limiting potentials of these two systems are shown in Figures 7A and 7B. For the manual system (Figure 7A) the potential for locating sound events increases linearly as a function of total battlefield rounds per minute to a maximum of 30 locations per hour at 30 rounds per minute. Beyond 30 rounds per minute the capability decays rapidly until slightly above 100 rounds per minute the system becomes saturated and no sound event locations could be discerned. However, due to the processing time involved in reading the charts, plotting the sound breaks and calculating the locations, this system is saturated at 30 locations per hour. For the automatic system (Figure 7B) the potential for locating sound events increases linearly as a function of total battlefield rounds per minute to a maximum of 60 locations per minute at 60 rounds per minute, the automatic system's capability also decays rapidly until at approximately 200 rounds per minute this system also becomes saturated and can produce no locations.

3.7 Sample Scenario.

A sample scenario consisting of 3 1/2 hours of daytime and 3 1/2 hours of nighttime combat was exercised using DIVLEV, AMSAA's two-sided division level wargame. The artillery force composition is listed in Table 4. All the required inputs were extracted from both scenarios and SREM was executed, modeling the capabilities of both a manual and an automatic system as mentioned above.

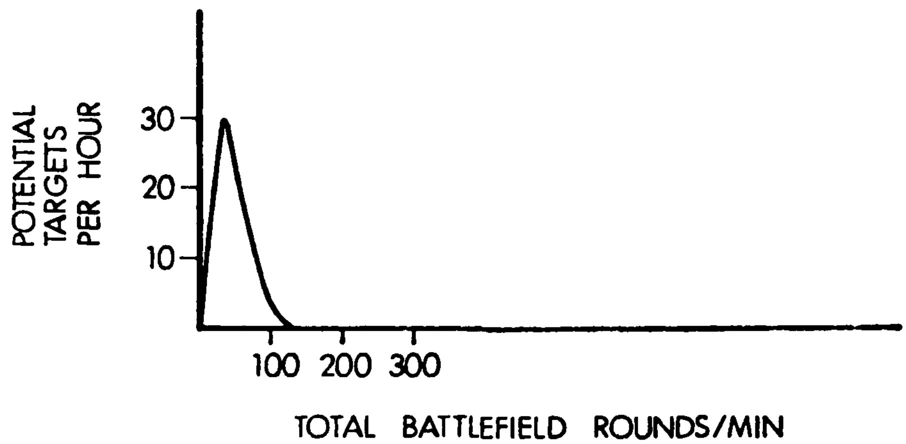

FIGURE 7A. Potential Target Production for a CT=6 System with a 2 Minute Target Processing Time

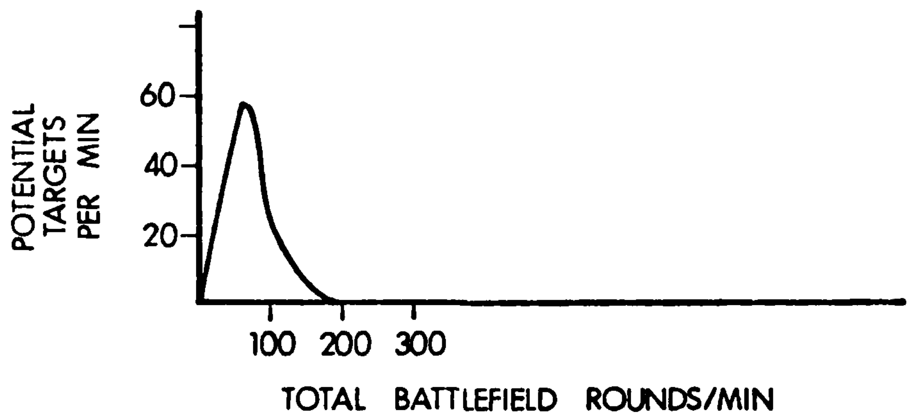

FIGURE 7B. Potential Target Production for a CT=12 System with a Negligible Target Processing Time

FORCE COMPOSITION

BLUE	1 ARMORED DIV + 2 EXTRA BRIGADES	
	1 ARMORED CAVALRY REGIMENT	
		26 - 4.2 MORT PLTS
		5 - 155 BNS
		2 - 155 BTRYS
		3 - 8" BNS
		1 - 175 BN
RED	4 TANK DIVISIONS	
	1 MOTORIZED RIFLE DIV	
		21 - 120 MORT BTRYS
		17 - 122 BNS
		14 - 152 BNS
		7 - MRL BNS
		7 - 130 BNS

TABLE 4

For the 3 1/2 hours of daytime combat (a covering force scenario), Figure 8 shows the distribution of rates of fire by percent of game time. Applying the capabilities of both a manual and automatic system as described above, a manual system (which is only operable at rates of fire below 100 rounds per minute) would be capable of making locations less than 1 percent of the game time. An automatic system (operable below 200 rounds per minute) would be capable of making locations approximately 9 percent of the game time.

Figure 9 shows the distribution of rates of fire by percent of game time for the 3 1/2 hours of night combat (which is nearer to the main battle area). Again applying the two diffrent capabilities, a manual system would still be limited in the amount of time it could be productive to less than 4 percent: however, an automatic system in this scenario would remain operable approximately 33 percent of the game time.

3.8 Sample Outputs.

The capabilities of both a manual and an automatic sound ranging system were modeled in SREM for both 3 1/2 hour segments of game time. Figure 10 shows for the daytime 3 1/2 hours of combat, the cumulative number of unique Red artillery batteries located as a function of game time for capabilities representing a manual system. During the first hour there was a relative lull during which five targets could be located. For the next 2 hours, the system was totally saturated until just past seven when one more location was made. Figure 11 gives the cumulative unique Red artillery batteries located as a function of game time for the capabilities representing an automatic system. During the early lull that the manual system was capable of making five locations, the automatic system was able to make nine locations. For the next 90 minutes this system was also saturated. When the next lull in the firing occurred, the automatic system was able to locate 19 additional Red artillery batteries, compared to one additional location for the manual system for the same time period.

Figure 12 is a manual system's capabilities during the 3 1/2-hour nighttime segment of the battle. During the first hour there was enough activity left from the daytime to saturate this system; there was then a half hour lull during which 10 Red artillery batteries could be located, but for the rest of the scenario this system was totally saturated. Figure 13 shows the automatic system's capabilities during the same time period. The automatic system was able to take advantage of the slightly lower rates of fire for the first hour and 45 minutes. During the next hour, there was an attempted river crossing during which the rates of fire increased to the point where they saturated the automated system. During the last 45 minutes, the system was again capable of producing targets at a usable rate. Figure 14 is a summary showing the total number of unique Red batteries located during both 3 1/2-hour segments of game time by the manual and automatic systems. This shows that increasing sound ranging capabilities to even a modest automated system increases the number of locations four to five times.

Figures 15-18 show the target production capability as a function of rate of fire for both the manual and automated systems. The rate of fire in these graphs was based on continuous fire at rates generated by DIVLEV.

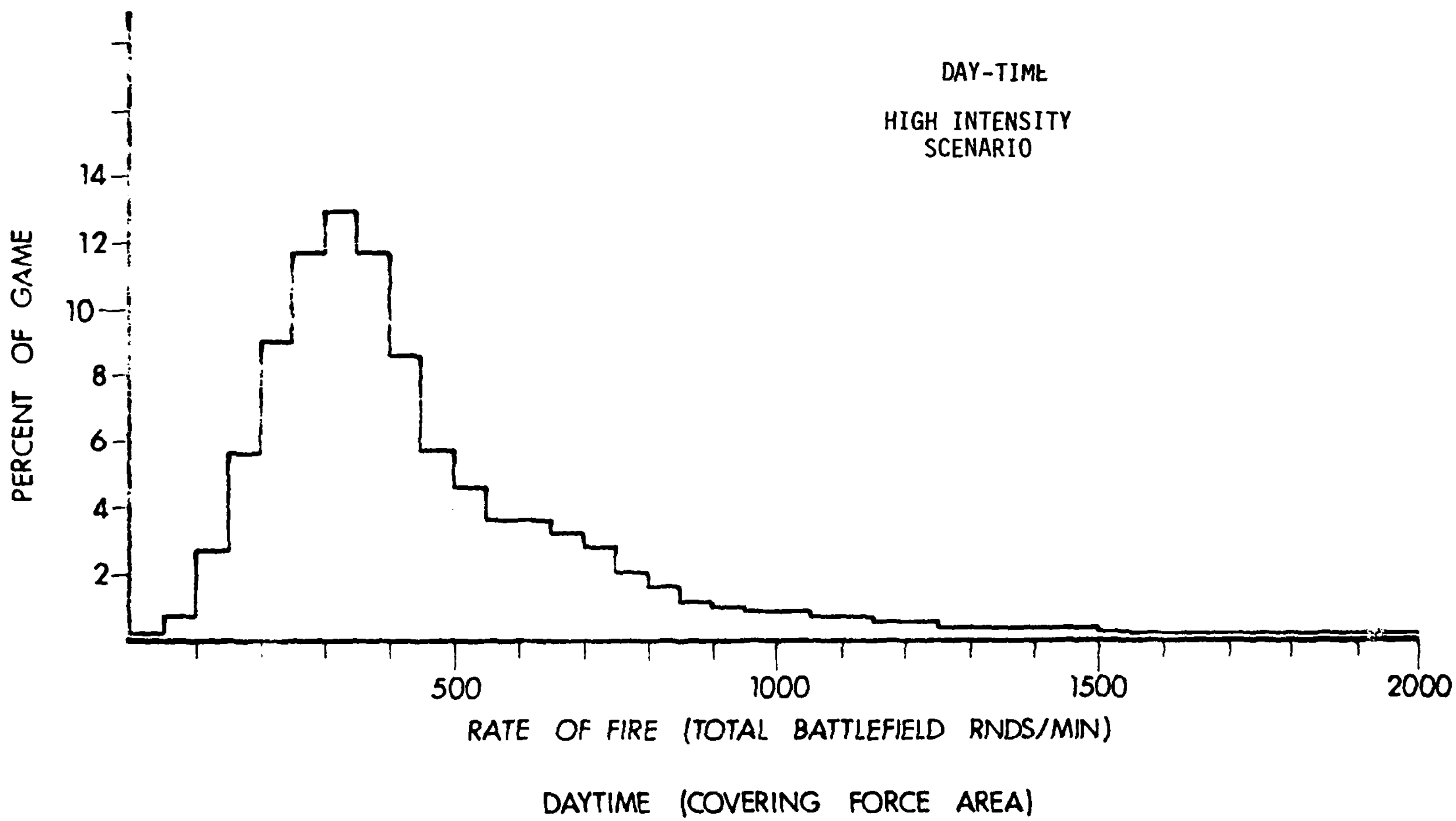

FIGURE 8. RATE OF FIRE AS A FUNCTION OF PERCENT OF GAME TIME (DAYTIME)

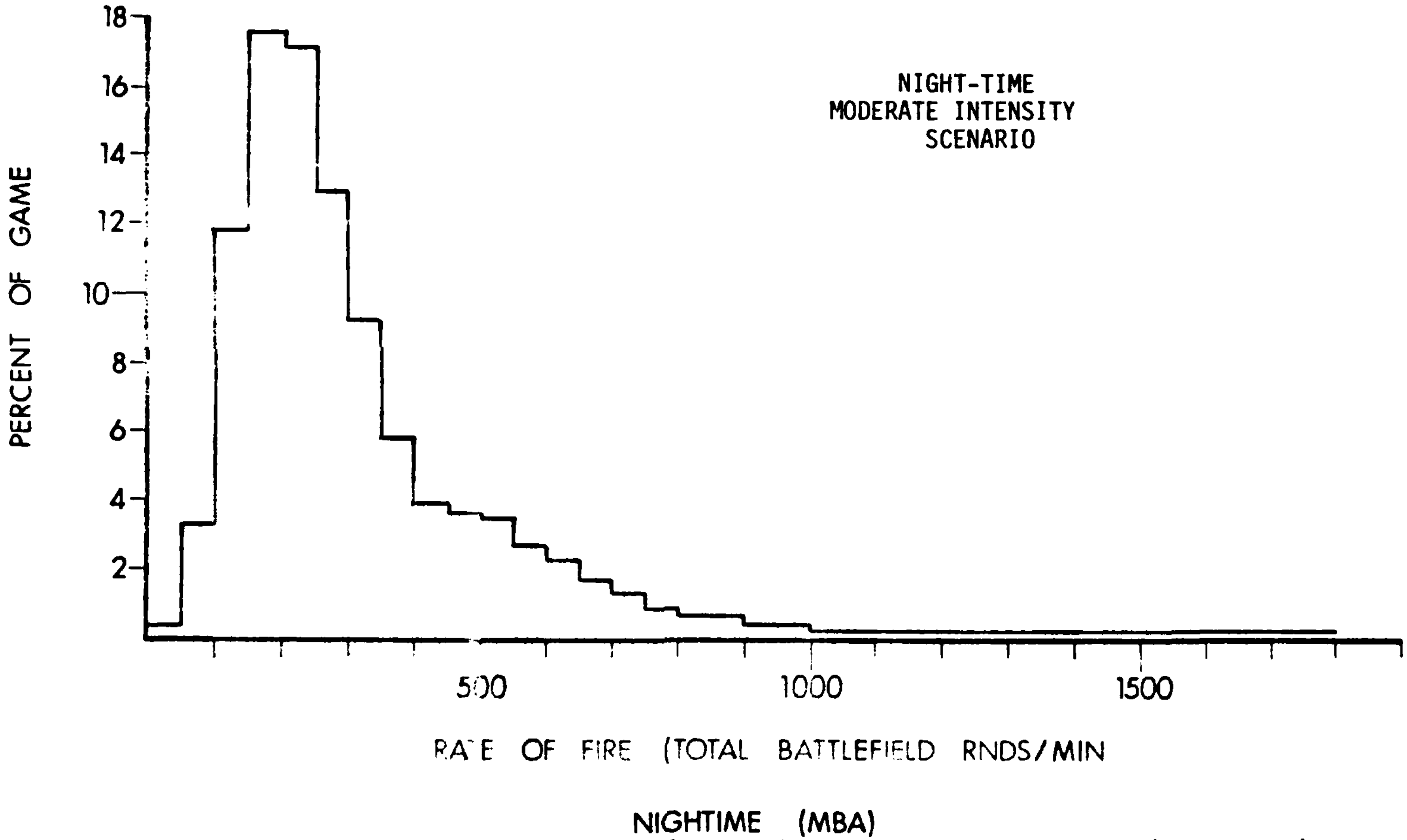

FIGURE 9. RATE OF FIRE AS A FUNCTION OF PERCENT OF GAME TIME (NIGHT-TIME)

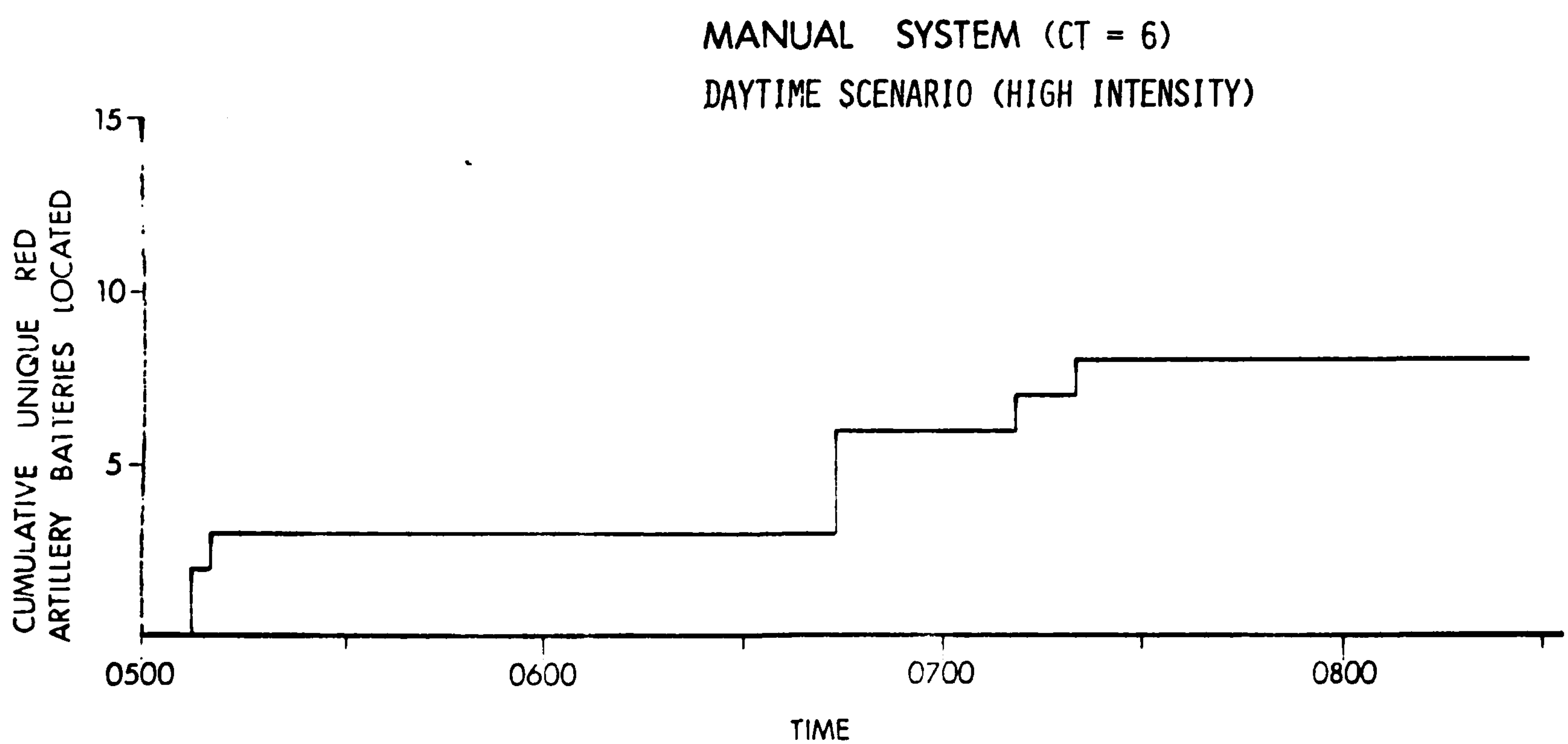

FIGURE 10. UNIQUE TARGETS LOCATED BY A MANUAL SYSTEM IN THE SAMPLE HIGH INTENSITY SCENARIO

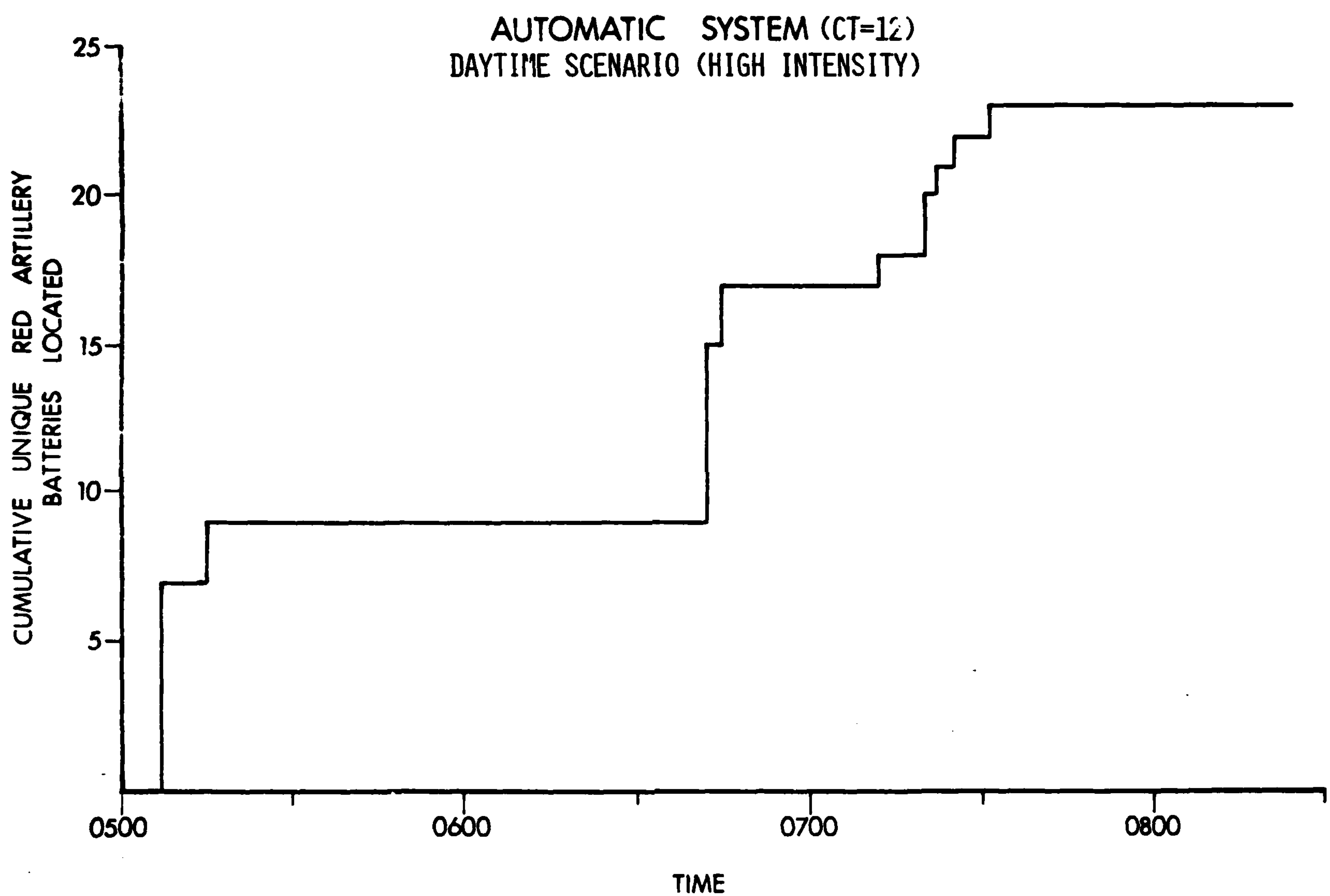

FIGURE 11. UNIQUE TARGETS LOCATED BY AN AUTOMATIC SYSTEM IN THE SAMPLE HIGH INTENSITY SCENARIO

MANUAL SYSTEM (CT = 6)

NIGHT TIME SCENARIO (MODERATE INTENSITY)

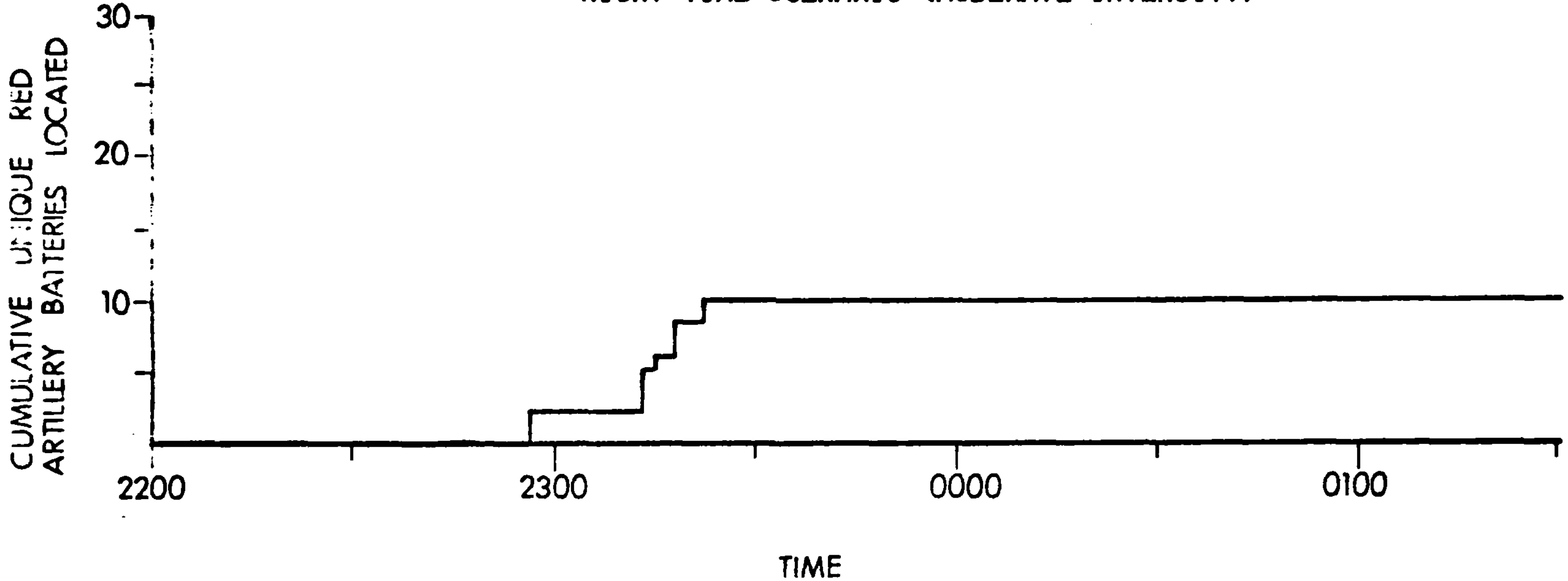

FIGURE 12. UNIQUE TARGETS LOCATED BY A MANUAL SYSTEM IN THE SAMPLE MODERATE INTENSITY SCENARIO.

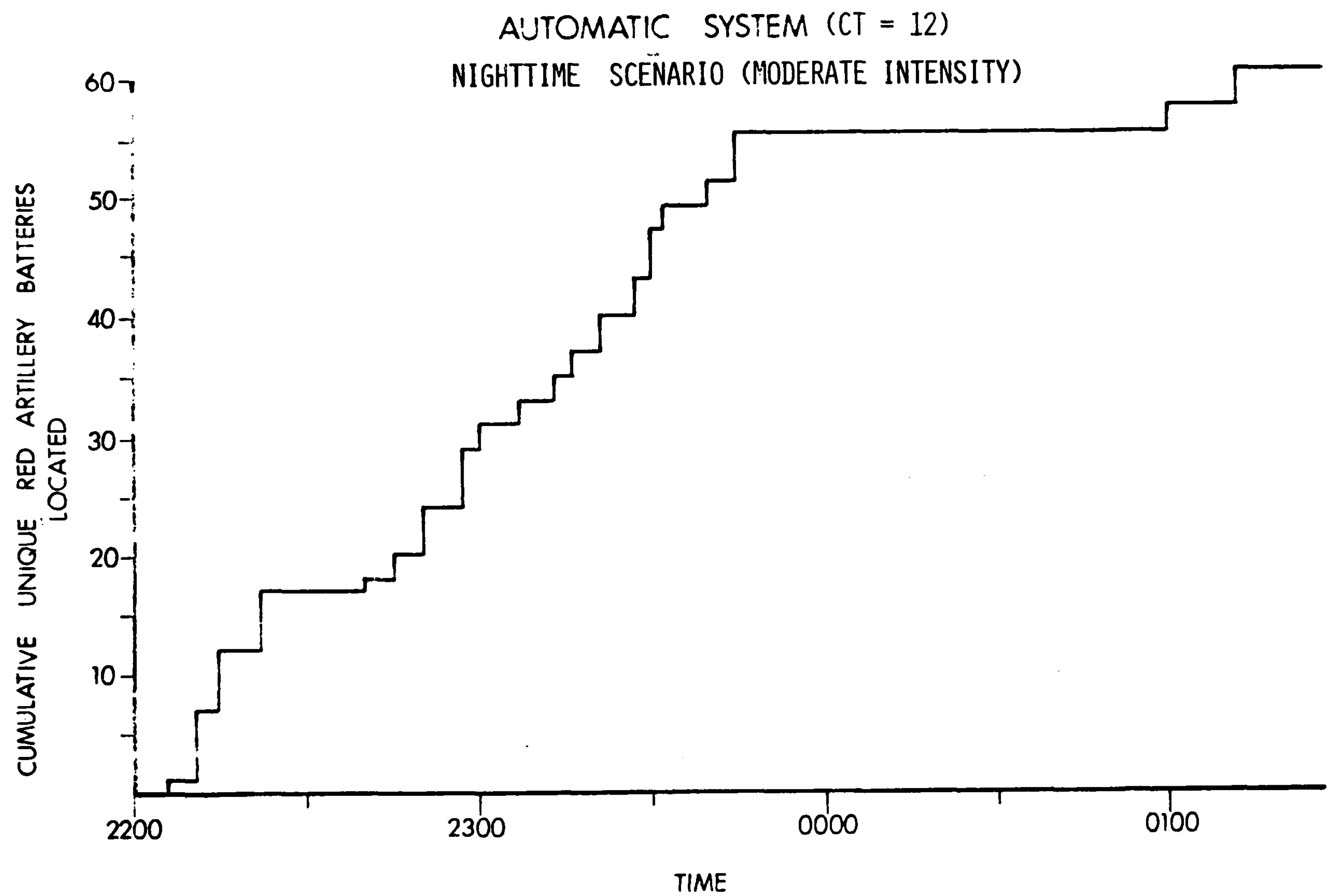

FIGURE 13. UNIQUE TARGETS LOCATED BY AN AUTOMATIC SYSTEM IN THE SAMPLE MODERATE INTENSITY SCENARIO.

SR CAPABILITY \ SCENARIO	DAY (COVERING FORCE)	NIGHT (MBA)
PRESENT MANUAL	6	10
MODEST AUTOMATIC	25	55

RED ARTILLERY BATTERIES LOCATED

FIGURE 14. SUMMARY OF UNIQUE SOUND RANGING ACQUISITIONS

MANUAL SYSTEM (CT=6)
STEADY STATE CONDITIONS
(MID INTENSITY)

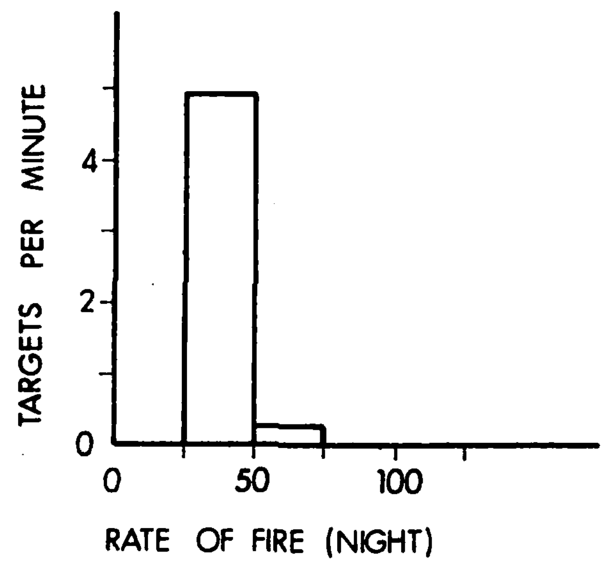

FIGURE 15 RATE OF UNIQUE TARGET PRODUCTION AS A FUNCTION OF THE RATES OF FIRE IN THE SAMPLE MODERATE INTENSITY SCENARIO

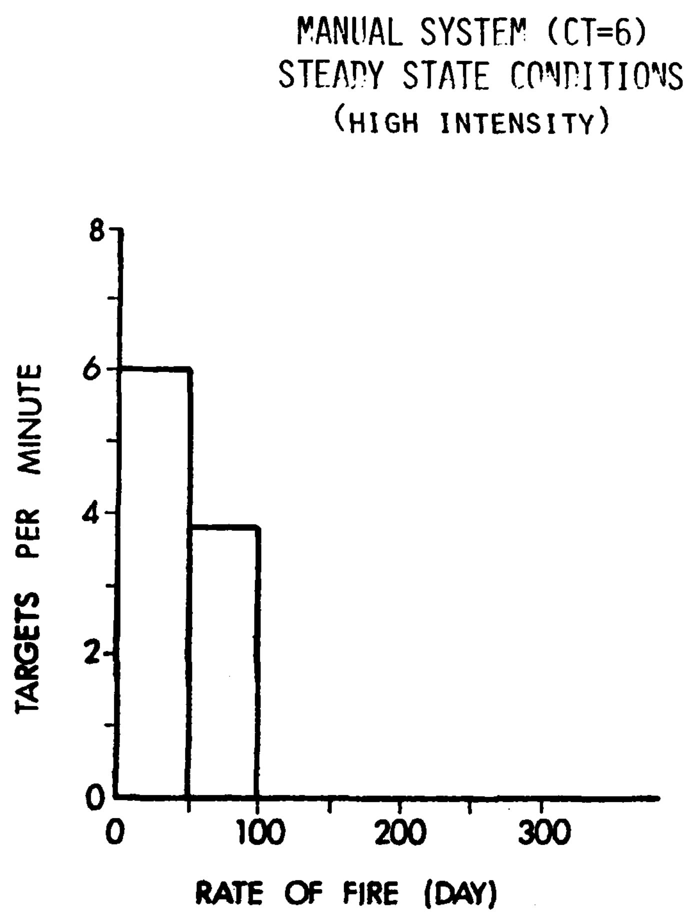

FIGURE 16 RATE OF UNIQUE TARGET PRODUCTION AS A FUNCTION OF THE RATES OF FIRE IN THE SAMPLE HIGH INTENSITY SCENARIO

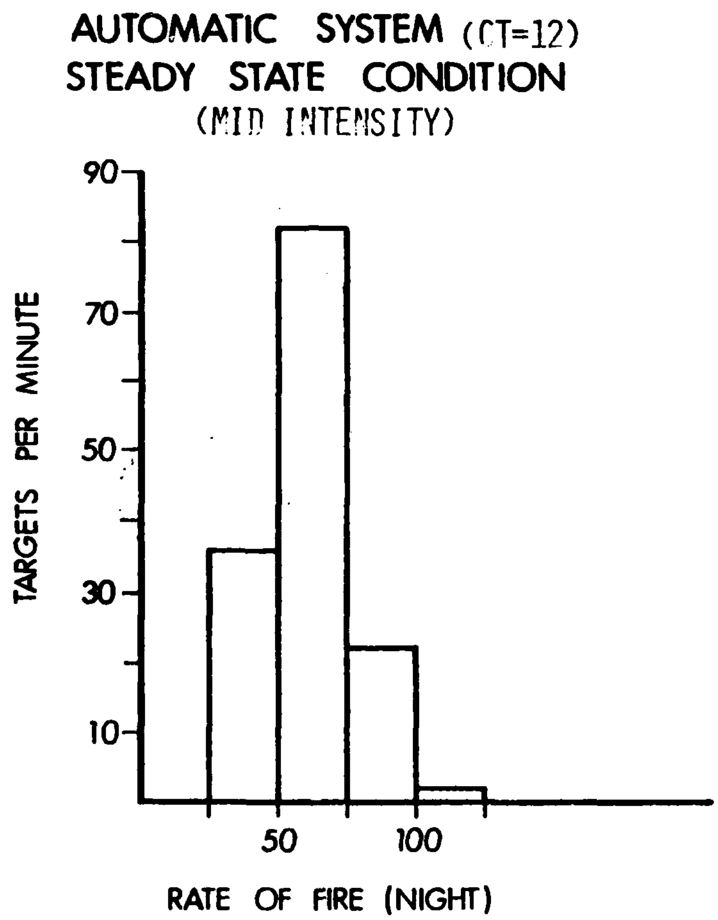

FIGURE 17 RATE OF UNIQUE TARGET PRODUCTION AS A FUNCTION OF THE RATES OF FIRE IN THE SAMPLE MODERATE INTENSITY SCENARIO

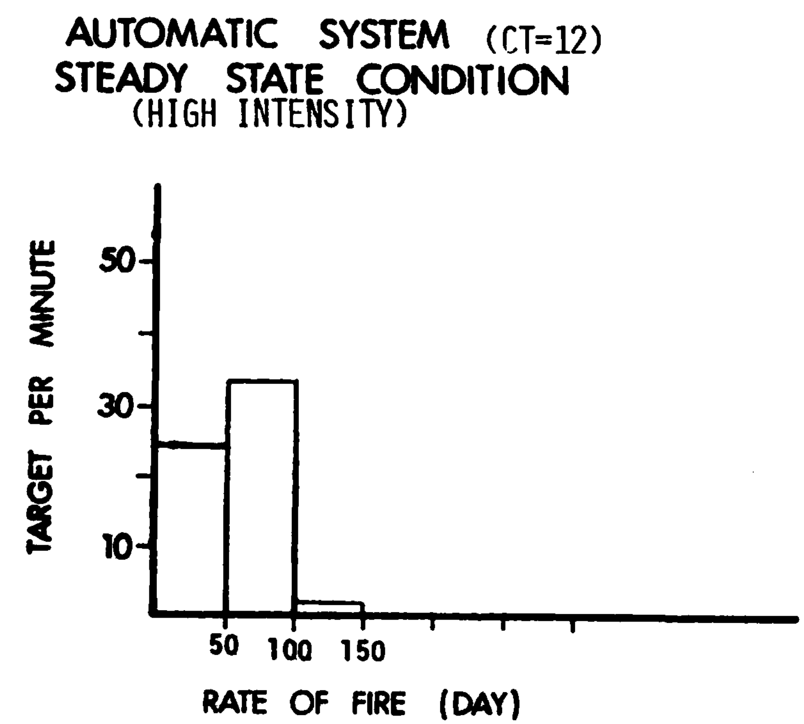

FIGURE 18 RATE OF UNIQUE TARGET PRODUCTION AS A FUNCTION OF THE RATES OF FIRE IN THE SAMPLE HIGH INTENSITY SCENARIO

Figures 19-22 show the cumulative number of red indirect artillery weapons capable of being located as a function of game time. When compared to the unique number of batteries capable of being located it can be seen that many batteries could have been located several times.

In a tactical situation, however, rates of fire rarely remain constant for more than a few seconds. When the average rate of fire is high it may be possible to still locate some targets during lulls in the firing. For the purpose of giving the reader a feel for these tactical fluctuations, the resolvable targets displayed in Figures 15-18 are also given in Figures 23-26, where in the latter figures the rates of fire are averaged over a five minute period around the six second window used for determining the number of discernable targets. In Figures 23-26, the potential of the hypothetical sound systems to locate hostile indirect fire weapons depends on the tactical fluctuations in the overall rates of fire as well as the sound system resolving capability.

4. SUMMARY

The Sound Ranging Effectiveness model was not designed to model any one system. SREM provides the distribution of sound events down to a 1-second resolution as would be expected in a tactical situation. The use in SREM of a critical threshold (CT) is a simplified parametric approach to modeling various sound ranging capabilities. In the event the user wishes to model a specific system in greater detail, SREM has been set up to allow the user to easily add subroutines reflecting their system model. The program will provide a sliding 6-second window which may be examined by any subroutines. The 6-second window will contain the amplitude and type of every sound event occurring in this window.

SREM has been developed to address the problems of loading and saturation of sound ranging systems. As such, it can provide to the analyst estimates of sound ranging performance or to the designer, future system requirements based on various scenarios. The authors feel that the passive operation and relatively low cost make future automatic sound ranging systems viable candidates for helping to satisfy the Army's counterbattery target acquisition needs. Although not addressed in this model, improved meteorological data acquisition systems and numerical plotting solutions are being developed which significantly improve sound ranging accuracy as compared with past capabilities. Accuracies better than 50 meters can be expected under favorable conditions such as nighttime or fog (utilizing short base subarrays and cross correlation techniques). It is also clear that future sound systems for the fast moving European scenarios will have to use radio links and automatic positioning systems which are under development to greatly enhance mobility over what has been achievable in the past.

In short, with improved accuracy and mobility on the horizon, the use of microprocessors for signal processing and mini computers for numerical plotting solutions would make automatic sound ranging a considerable target acquisition asset as illustrated in SREM example scenario.

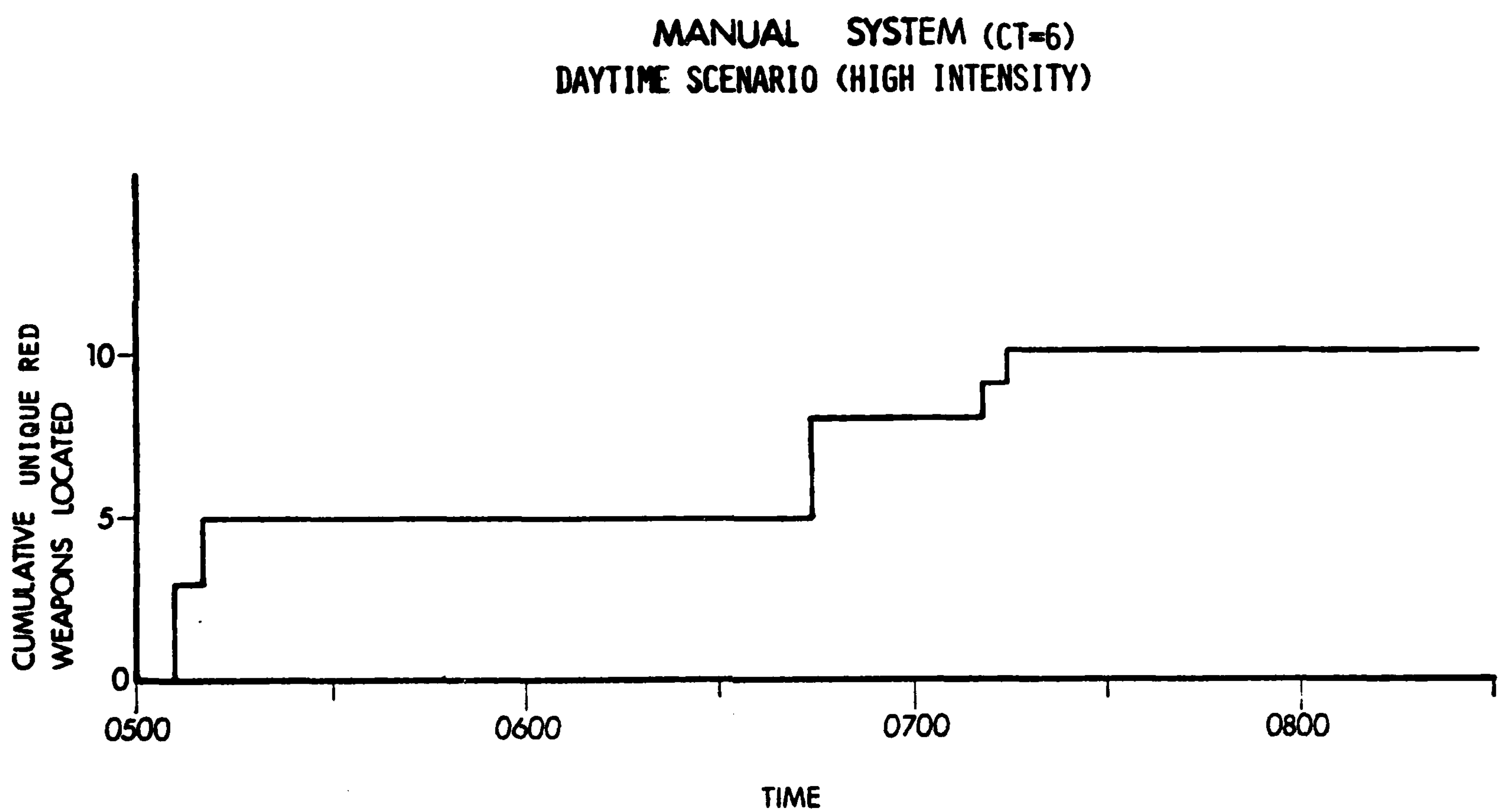

FIGURE 19 TOTAL TARGETS LOCATED BY A MANUAL SYSTEM IN THE SAMPLE HIGH INTENSITY SCENARIO

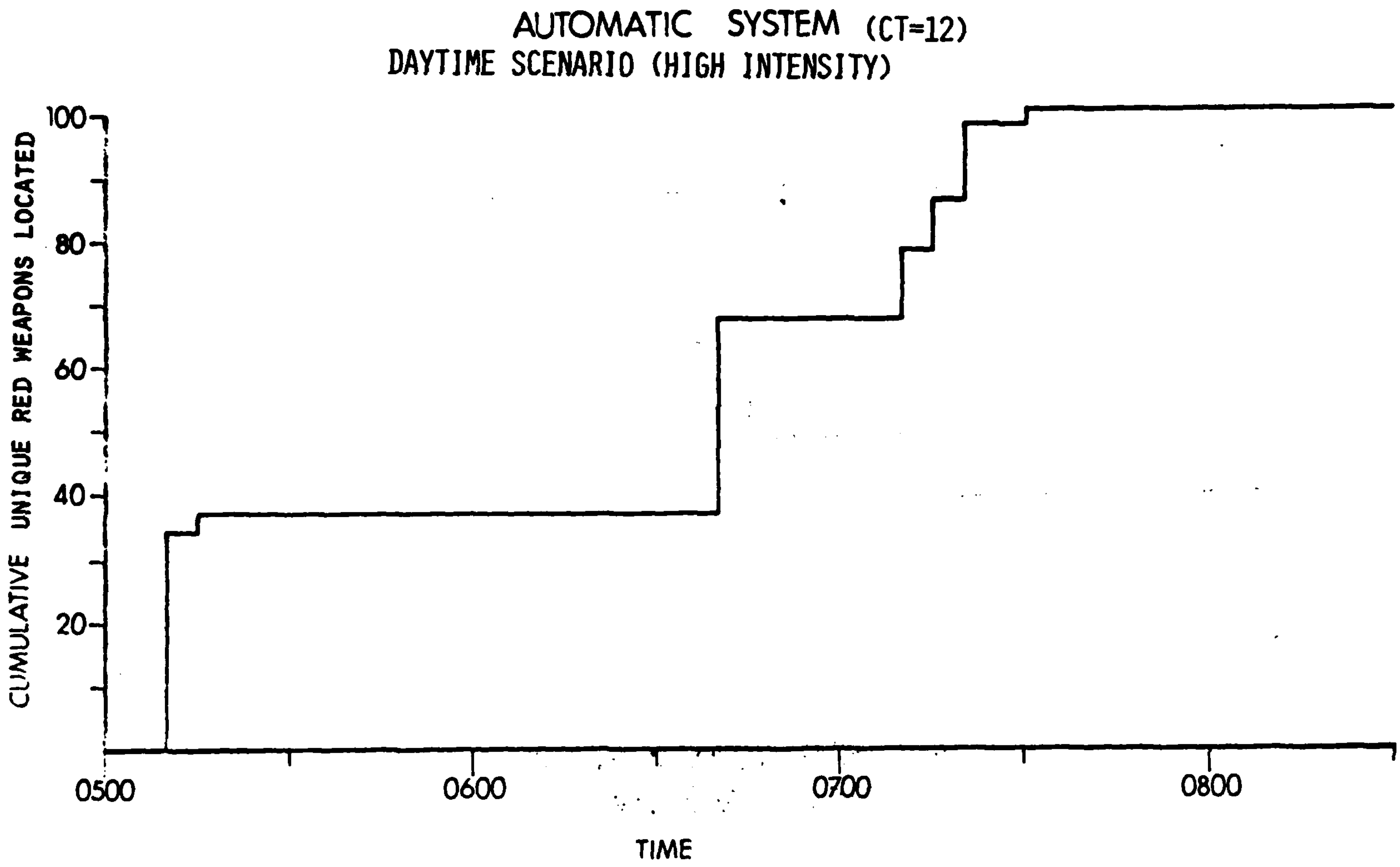

FIGURE 20 TOTAL TARGETS LOCATED BY AN AUTOMATIC SYSTEM IN THE SAMPLE HIGH INTENSITY SCENARIO

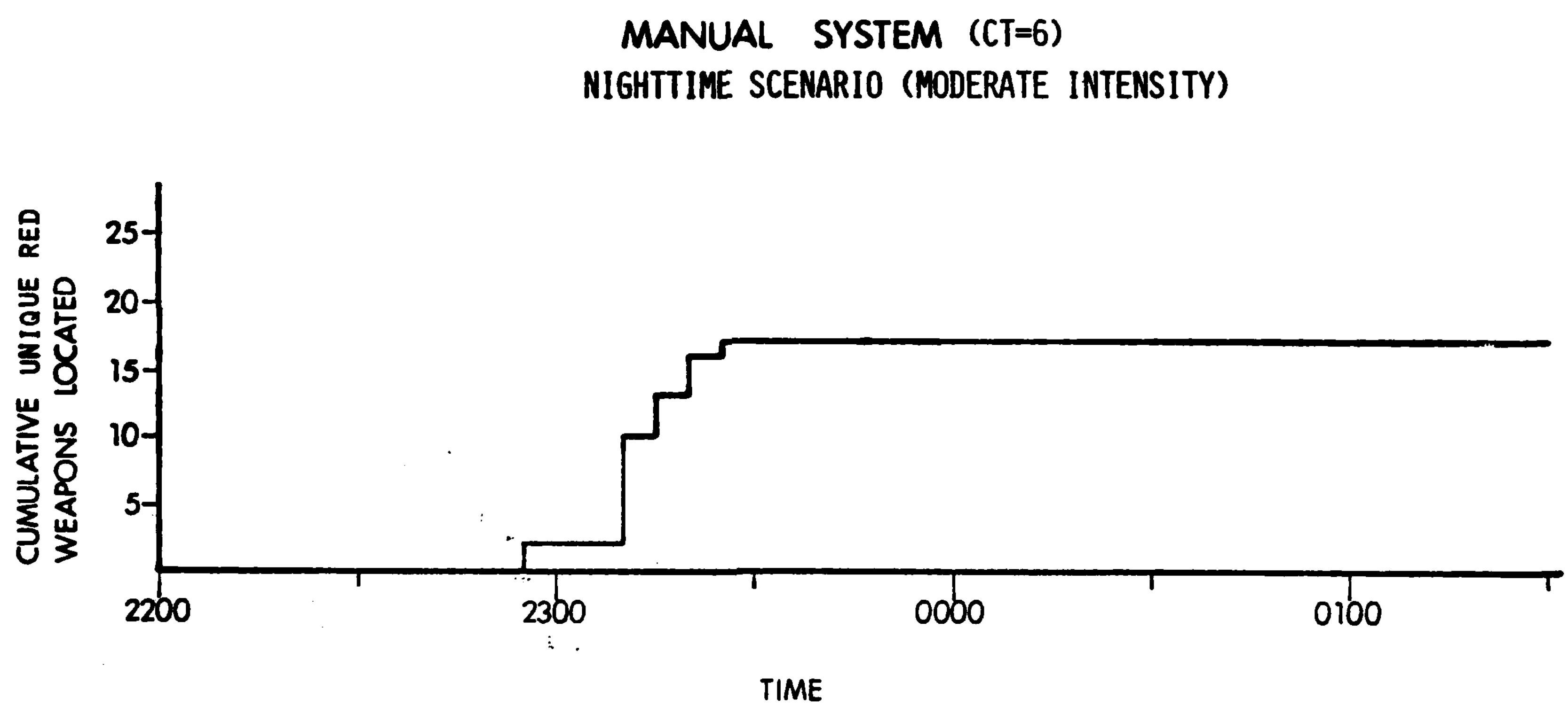

FIGURE 21 TOTAL TARGETS LOCATED BY A MANUAL SYSTEM IN THE SAMPLE MODERATE INTENSITY SCENARIO

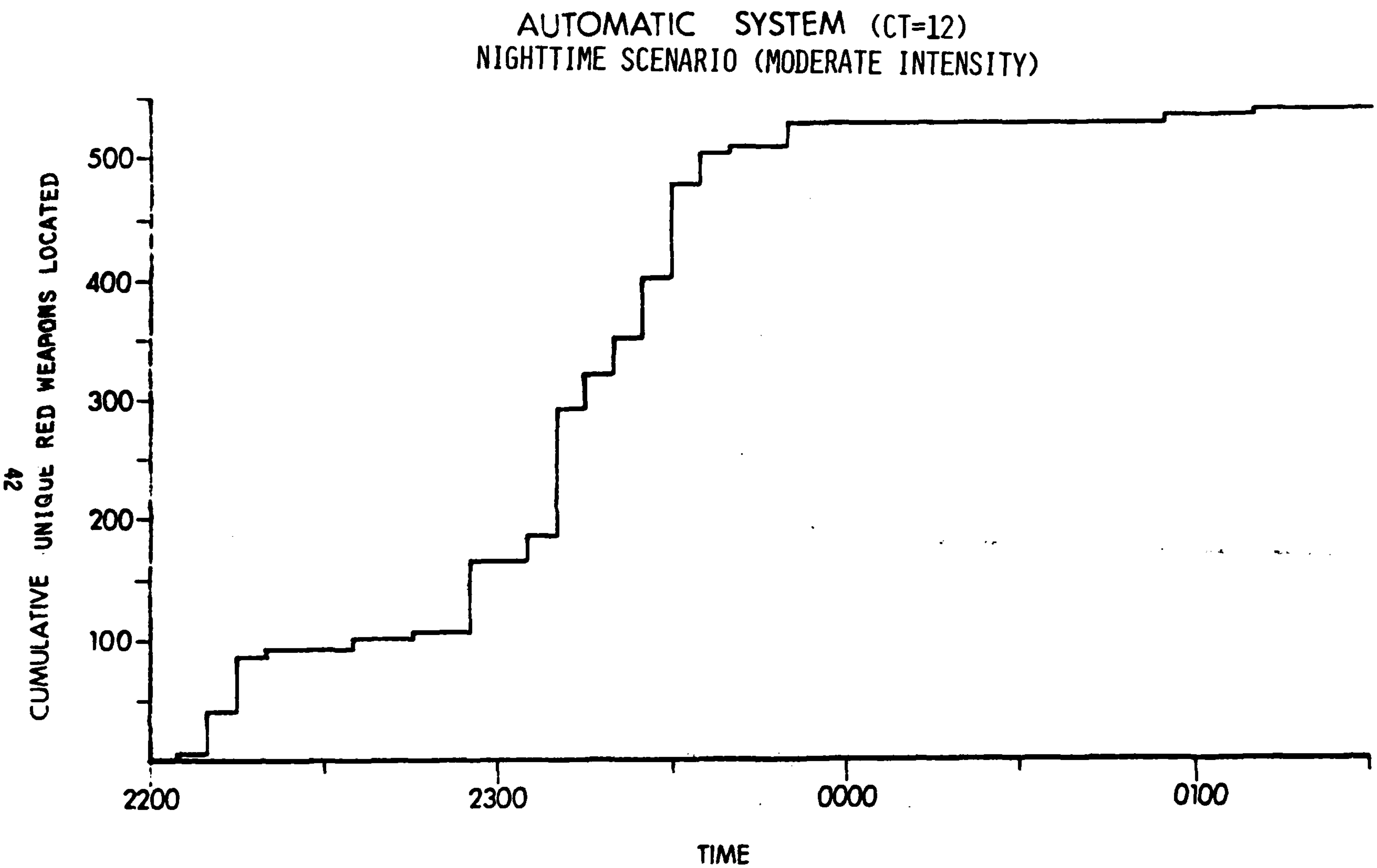

FIGURE 22 TOTAL TARGETS LOCATED BY AN AUTOMATIC SYSTEM IN THE SAMPLE MODERATE INTENSITY SCENARIO

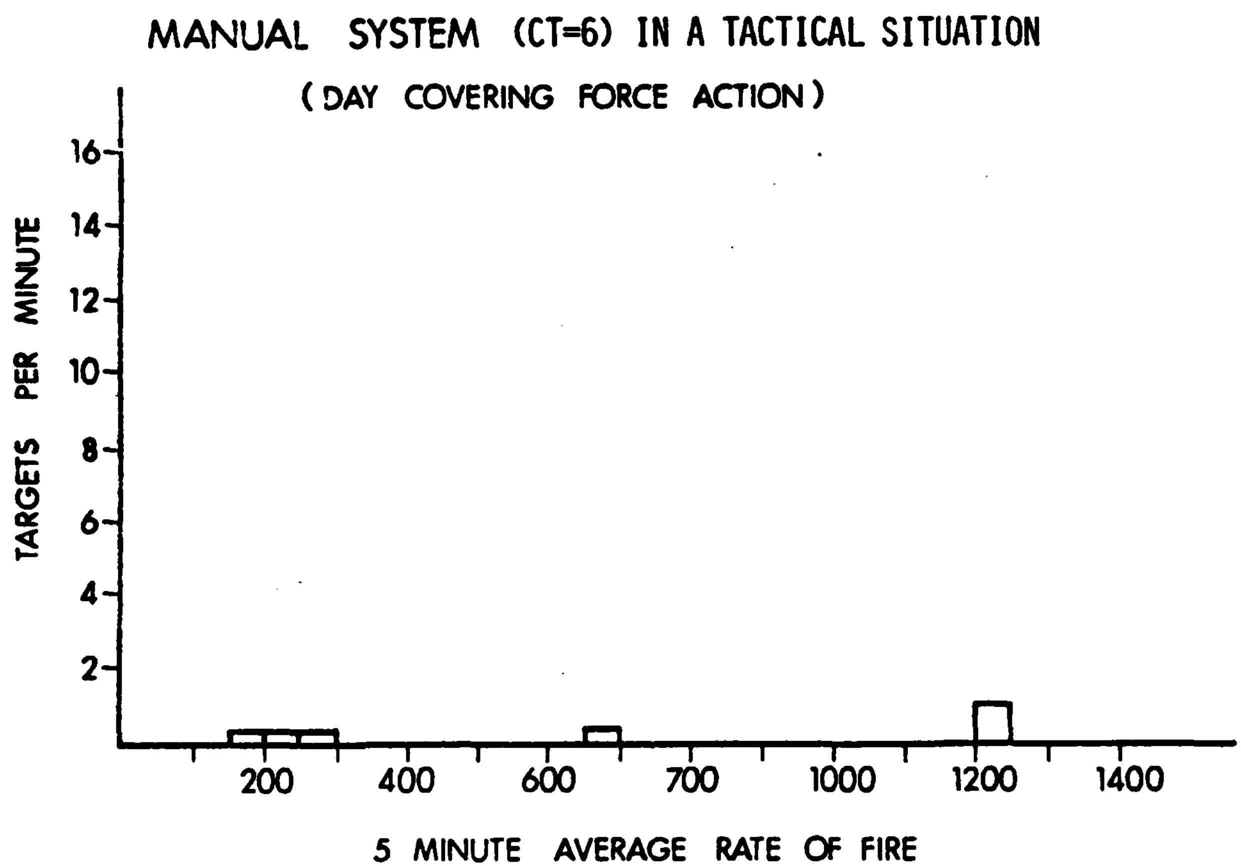

FIGURE 23 RATE OF UNIQUE TARGET PRODUCTION AS A FUNCTION OF THE RATE OF FIRE IN THE SAMPLE HIGH INTENSITY SCENARIO

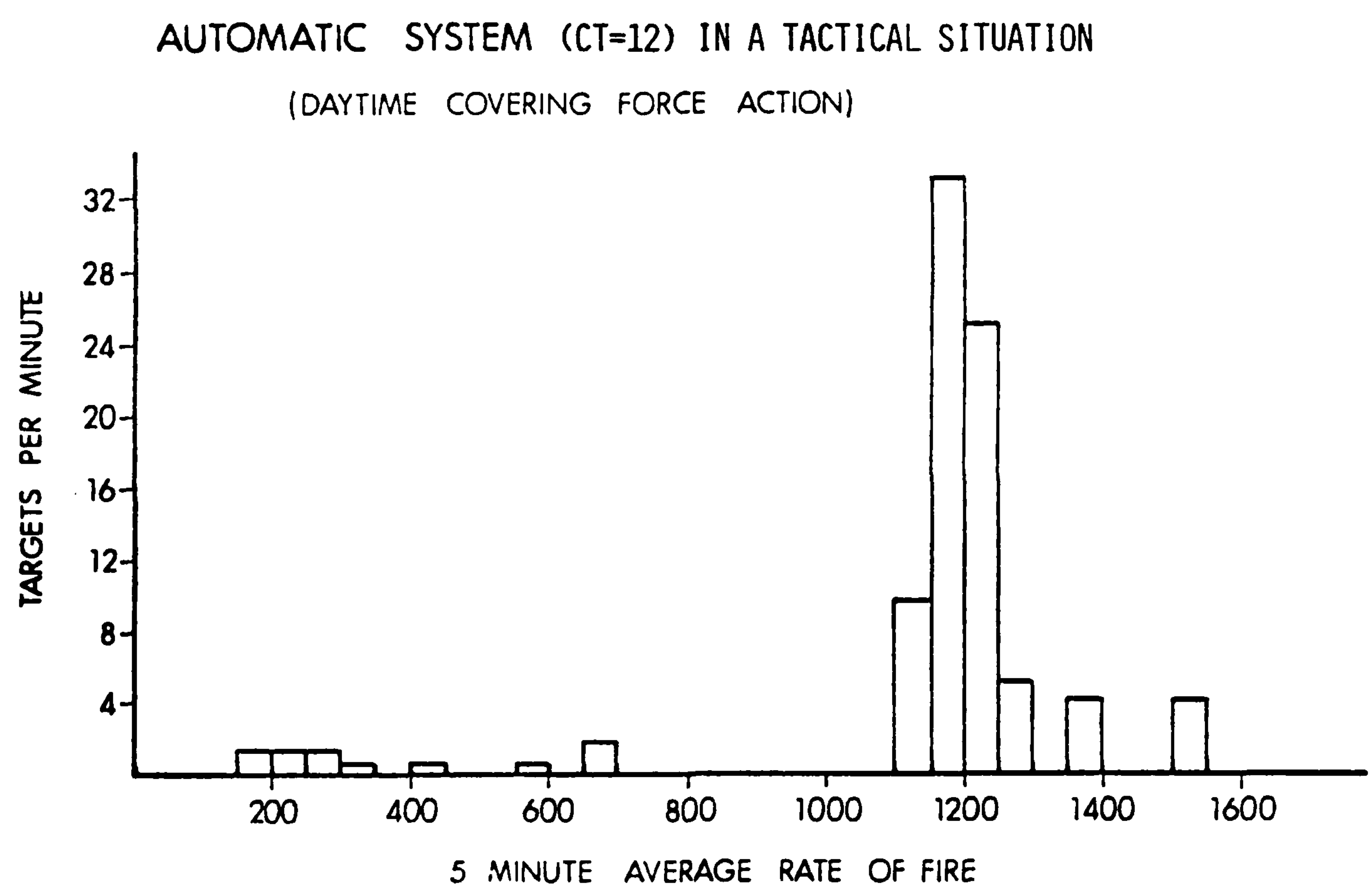

FIGURE 24 RATE OF UNIQUE TARGET PRODUCTION AS A FUNCTION OF THE RATE OF FIRE IN THE SAMPLE HIGH INTENSITY SCENARIO

MANUAL SYSTEM (CT=6) IN A TACTICAL SITUATION

(NIGHTIME MBA)

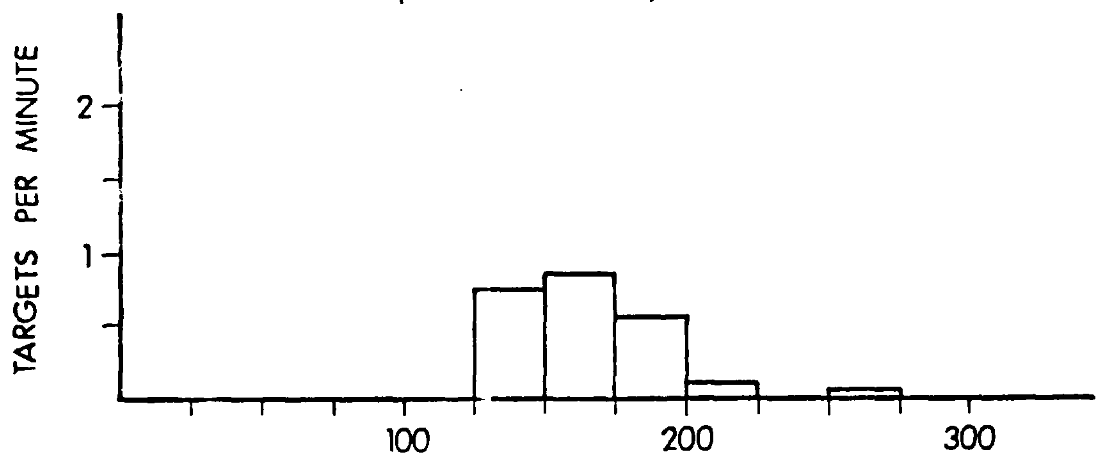

FIGURE 25 RATE OF UNIQUE TARGET PRODUCTION AS A FUNCTION OF THE RATE OF FIRE IN THE SAMPLE MODERATE INTENSITY SCENARIO

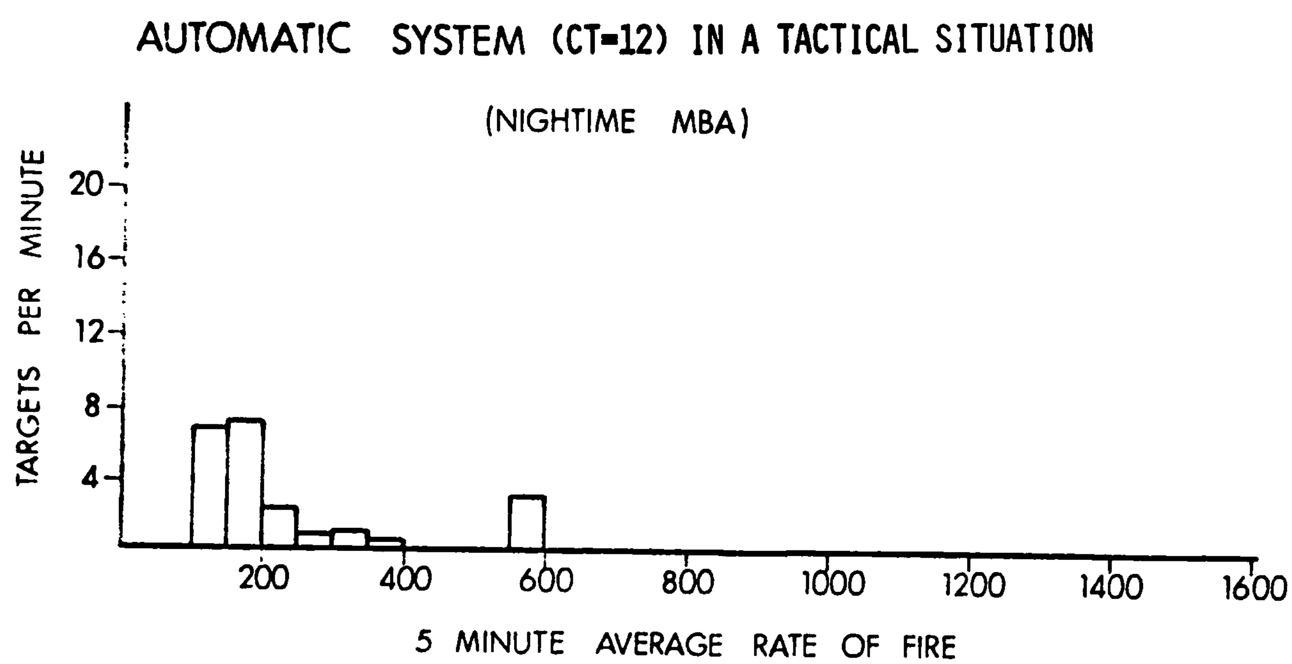

FIGURE 26 RATE OF UNIQUE TARGET PRODUCTION AS A FUNCTION OF THE RATE OF FIRE IN THE SAMPLE MODERATE INTENSITY SCENARIO

APPENDIX A

SREM USER'S GUIDE

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APPENDIX A

THE SOUND RANGING EFFECTIVENESS MODEL (SREM) USER'S GUIDE

SREM is designed to examine the loading problems a sound ranging system will experience in a given scenario. To do this, SREM receives as input both Red and Blue, direct and indirect firing missions and Close Air Support missions. Sound events are generated for each of these missions to account for the muzzle blast for artillery, and the impact sound event for artillery, direct fire and Close Air Support missions. These sound events are then time ordered based on the time they would reach the sound base and are then examined to see when the sound ranging system being modeled would be capable of making locations. SREM also keeps track of Red muzzle events so that when the sound system is capable of making locations, it counts the number of unique Red muzzle events which would be available to be located.

SREM requires the initialization of the sound base location, start and stop times, one parameter describing the saturation limit if the system being modeled, and one describing the resolution in terms of rate of fire you wish to have in the results. The initialization procedure and where to locate the required data statements are described in detail in this guide.

The Sound Ranging Effectiveness Model is presently configured to receive its inputs from DIVLEV, a two-sided division level wargame; DIVLEV generates an input file which is later read by SREM. In the event the user wishes to generate an input file, the format required for this file is included.

The sound ranging effectiveness model was written on a CDC 7600 computer and contains some coding peculiar to that system. The following are CDC unique and will have to be changed if the program is run on a different system.

1. The first line of the program is a program statement which declares how files are to be used.

2. Several large arrays are found in "LEVEL 2" statements, this places these arrays in an auxiliary portion of memory. These are large arrays and some provision may be required in order to handle them.

Required initialization inputs for SREM

- o Location of sound base to nearest 100 meters*

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* The user should be careful to note if any special coordinate systems are being used to create the input. SREM assumes all coordinates are given to the nearest 100 meters.

ESNDBS = Easting — 3 Digit UTM coordinate
NSNDBS = Northing — 3 Digit UTM coordinate

- Starting time =

  MASTIM - standard military time.

  The starting time need not agree with the starting time of the input file. The program will step through the input file until a time equal to MASTIM is reached.

- Stop time =

  MAXTIM - Standard military time.

  If the simulated time step reaches this time before it reaches the end of file SREM treats it as an end of file.

- Critical threshold

  CT = Maximum number of sound events occurring in a 6-second period during which all sound events in that window could be located. (Max = 18)

- Method of calculating Rate of Fire

  SYS = 1, Rate of fire is calculated by the 5-minute average rate of fire immediately preceding the 6-second window in question.

  = 2, Rate of fire is calculated by taking the number of muzzle events in the 6-second window and extrapolating it to 1 minute.

- Resolution of Summary output

  ROF = Increment of rate of fire for summary outputs. (i.e.,

  ROF=25 will display all outputs on rate of fire steps of 25.)

All the required inputs for initialization can be found in data statements in the main routine. The locations of the various data statements are in Table 1.

The input file must be unformatted records eight words per record. Records are read into array MISHUN one at a time. The records for indirect fire missions must follow the format found in Table 2, for a direct fire mission Table 3, and for a close air support mission Table 4.

TABLE 1

LOCATION OF DATA STATEMENTS FOR INITIALIZATION

- Sound Base location

  Easting (ESNDBS) = line 30 main routine

  Northing (NSNDBS) = line 31 main routine

- Starting time

  MASTIM = line 32 main routine

- Stop time

  MAXTIM = line 33 main routine

- Critical threshold

  CT = line 34 main routine

- Method of calculating rate of fire

  SYS = line 35 main routine

- Resolution of outputs

  ROF = line 36 main routine

TABLE 2

SREM INPUT FILE (MISHUN (I), I = 1,8)

- Artillery Missions (indirect fire)

  MISHUN (1) = Number of weapons in this battery.

  MISHUN (2) = Time this artillery mission will begin.

  MISHUN (3) = Easting coordinate of target to nearest 100 meters.

  MISHUN (4) = Northing coordinate of target to nearest 100 meters.

  MISHUN (5) = Duration of this mission.

  MISHUN (6) = Easting coordinate of firing weapon to nearest 100 meters.

  MISHUN (7) = Northing coordinate of firing weapon to nearest 100 meters.

  MISHUN (8) = Coded number;

  First 3 digits = unique 3 digit identifier for this battery.

  Second 2 digits = resource number (See Table 5)

  Last digit = force; 1 = Blue

  2 = Red

TABLE 3

- Direct Fire Missions

  MISHUN (1) = Number of rounds fired in this minute by this weapon.

  MISHUN (2) = Time this direct fire mission began.

  MISHUN (3) and MISHUN (4) = Zero (0)

  MISHUN (5) = Duration of this firing mission (in minutes).

  MISHUN (6) = Easting coordinate of weapon firing to nearest 100 meters.

  MISHUN (7) = Northing coordinate of weapon firing to nearest 100 meters.

  MISHUN (8) = Coded number (same as indirect fire).

TABLE 4

- Close Air Support Mission

MISHUN (1) = Coded number;

First digit = type of ordnance as follows:

BLUE	TYPE #	RED
CBU - 24	1	RBK - 500
Rockeye	2	RBK - 250
Maverick	3	500 LB Bomb

Last 2 digits = number of sticks of this type ordnance.

A stick is as follows:

$$\left.\begin{array}{l}\text{CBU-24}\\ \text{Rockeye}\\ \text{RBK-500}\\ \text{RBK-250}\end{array}\right\}\ \text{8 each}$$

Maverick - 2 each
500 lb Bomb - 2 each

MISHUN (2) = Time this ordnance was delivered.

MISHUN (3) = Easting coordinate for this target to the nearest 100 meters.

MISHUN (4) = Northing coordinate for this target to the nearest 100 meters.

MISHUN (5) = One (1)

MISHUN (6) and MISHUN (7) = Zero (0)

MISHUN (8) = Coded number (same as direct fire).

TABLE 5

Blue Weapon	Resource Number	Red Weapon
M60A3 Tank w/105mm gun	2	T72 tank w/125mm gun
	3	APC, BMP w/Sagger
Cobra/tow	5	HIND-A w/Sagger
Mortar, 81mm (M29A1)	6	Mortar, 120mm (m1938-43)
	9	BRDM w/Sagger
155mm Howitzer SP (M109A1)	11	122mm Howitzer (D-30)
8-inch Howitzer SP (M110E2)	12	152mm G/H (D-20)
175mm Gun SP (M107)	13	122mm MRL (BM-21)
M113A1 w/tow	20	Sagger, Manpack
Tow, Ground Mounted	21	122mm Howitzer, SP(M1974)
	22	152mm G/H, SP (M1973)
Mortar, 4.2-inch SP	28	130mm Gun (M-46)
	36	240mm MRL
Jet Aircraft, CAS	37	Jet Aircraft, CAS

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APPENDIX B
SAMPLE RUN

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APPENDIX B

SAMPLE RUN

A 10-minute simulation was set up for demonstration purposes. The initialization values used are in Table B-1. The input records used are in Table B-2. Figures B-1 through B-11 contain the minute by minute record available as an output of all the sound events. This output is described in detail on page of the main report. Figure B-12 is an output which provides the average number of Red muzzle events when the total number of sound events was 1,2,3, ... etc. Figures B-13 and B-14 are outputs which provide for each minute of the game the total number of potential targets and the total number of unique targets respectively.

Figure B-15 provides for each rate of fire band, what percentages of the total game time a sound ranging system would be capable of locating 0,1,2,3, ... etc. weapons. For example, the rate of fire was between 25 and 50 rounds per minute and it was possible to locate 2 Red muzzle events 14.44 percent of the total game time. Also, the rate of fire was between 25 and 50 rounds per minute and no Red muzzle events occurred during 22.5 percent of the total game time.

The "LOST" column indicates what percentage of the game time there were Red muzzle events but the threshold was exceeded and no locations could be made. The "TOT" column indicates what percentage of game time the rate of fire fell within that band.

Based on the previous outputs, it was determined what percentage of the time it was possible to locate 1,2,3, ... etc. Red muzzle events when the rate of fire was within a specific band.

For example, in Figure B-16 under the column marked "2" and in row marked "25 - 50" you will find the number 15.07. This indicates that 15.07 percent of the time that the rate of fire was within the 25 - 50 rounds per minute band, it was possible to locate 2 Red muzzle events.

Figure B-17 is a 5-minute moving average of the rate of fire by bands. Since this was a very short run, all the rates of fire fell within 25 - 50 rounds per minute.

SAMPLE INPUTS

Below are the inputs for the sample run.

ESNDBS = 460

NSNDBS = 230

The sound base is located at 460 east, 230 north, (SREM assumes 100 meter accuracy.)

MASTIM - 10430

The start time for this run will be day 1 at 0430. (SREM has a 1 minute time resolution.)

MAXTIM = 10441

The stop time for this run will be day 1 at 0441. (SREM stops when it reaches this time, any inputs with this time will be ignored.)

CT = 6

The system being modeled in this run has the capability of discerning targets when there are no more then 6 overlapping sound events in a six second window.

SYS = 1

For this output we wish to have the rates of fire calculated based on the 5 minutes immediately preceding the six second window.

ROF = 25

All the outputs for this run will be displayed in rate of fire steps of 25.

TABLE B-1

SEC	MIN = 1(43) TOT	AMPLITUDE IN DB > 110	105-110	100-105	95-100	92-95	89-92	87-89	84-87	80-84	70-80	< 70
1		/	/	/	/	/	/	/	/	/	/	/
2		/	/	/	/	/	/	/	/	/	/	/
3		/	/	/	/	/	/	/	/	/	/	/
4		/	/	/	/	/	/	/	/	/	/	/
5		/	/	/	/	/	/	/	/	/	/	/
6		/	/	/	/	/	/	/	/	/	/	/
7		/	/	/	/	/	/	/	/	/	/	/
8		/	/	/	/	/	/	/	/	/	/	/
9		/	/	/	/	/	/	/	/	/	/	/
10		/	/	/	/	/	/	/	/	/	/	/
11		/	/	/	/	/	/	/	/	/	/	/
12		/	/	/	/	/	/	/	/	/	/	/
13		/	/	/	/	/	/	/	/	/	/	/
14		/	/	/	/	/	/	/	/	/	/	/
15		/	/	/	/	/	/	/	/	/	/	/
16		/	/	/	/	/	/	/	/	/	/	/
17		/	/	/	/	/	/	/	/	/	/	/
18		/	/	/	/	/	/	/	/	/	/	/
19		/	/	/	/	/	/	/	/	/	/	/
20		/	/	/	/	/	/	/	/	/	/	/
21		/	/	/	/	/	/	/	/	/	/	/
22		/	/	/	/	/	/	/	/	/	/	/
23		/	/	/	/	/	/	/	/	/	/	/
24		/	/	/	/	/	/	/	/	/	/	/
25		/	/	/	/	/	/	/	/	/	/	/
26		/	/	/	/	/	/	/	/	/	/	/
27		/	/	/	/	/	/	/	/	/	/	/
28		/	/	/	/	/	/	/	/	/	/	/
29		/	/	/	/	/	/	/	/	/	/	/
30		/	/	/	/	/	/	/	/	/	/	/
31		/	/	/	/	/	/	/	/	/	/	/
32		/	/	/	/	/	/	/	/	/	/	/
33		/	/	/	/	/	/	/	/	/	/	/
34		/	/	/	/	/	/	/	/	/	/	/
35		/	/	/	/	/	/	/	/	/	/	/
36		/	/	/	/	/	/	/	/	/	/	/
37		/	/	/	/	/	/	/	/	/	/	/
38		/	/	/	/	/	/	/	/	/	/	/
39		/	/	/	/	/	/	/	/	/	/	/
40		/	/	/	/	/	/	/	/	/	/	/
41		/	/	/	/	/	/	/	/	/	/	/
42		/	/	/	/	/	/	/	/	/	/	/
43		/	/	/	/	/	/	/	/	/	/	/
44		/	/	/	/	/	/	/	/	/	/	/
45		/	/	/	/	/	/	/	/	/	/	/
46		/	/	/	/	/	/	/	/	/	/	/
47		/	/	/	/	/	/	/	/	/	/	/
48		/	/	/	/	/	/	/	/	/	/	/
49		/	/	/	/	/	/	/	/	/	/	/
50		/	/	/	/	/	/	/	/	/	/	/
51		/	/	/	/	/	/	/	/	/	/	/
52		/	/	/	/	/	/	/	/	/	/	/
53		/	/	/	/	/	/	/	/	/	/	/
54		/	/	/	/	/	/	/	/	/	/	/
55		/	/	/	/	/	/	/	/	/	/	/
56		/	/	/	/	/	/	/	/	/	/	/
57		/	/	/	/	/	/	/	/	/	/	/
58		/	/	/	/	/	/	/	/	/	/	/
59		/	/	/	/	/	/	/	/	/	/	/
60		/	/	/	/	/	/	/	/	/	/	/

FIGURE B-1

SEC	MIN = 10431 TOT	> 110	105-110	100-105	95-100	92-95	89-92	87-89	84-87	80-84	70-80	< 70
					AMPLITUDE		IN	DB				
1		/	/	/	/	/	/	/	/	/	/	/
2		/	/	/	/	/	/	/	/	/	/	/
3		/	/	/	/	/	/	/	/	/	/	/
4		/	/	/	/	/	/	/	/	/	/	/
5		/	/	/	/	/	/	/	/	/	/	/
6	4	/	/	/	/	/	/	/	/	1/	3/	/
7	4	/	/	/	/	1/	/	1/	/	2/	/	/
8		/	/	/	/	/	/	/	/	/	/	/
9		/	/	/	/	/	/	/	/	/	/	/
10	1	/	/	/	/	/	/	/	/	/	1/	1/
11	2	/	/	/	/	/	/	/	/	/	2/	/
12		/	/	/	/	/	/	/	/	/	/	/
13		/	/	/	/	/	/	/	/	/	/	/
14		/	/	/	/	/	/	/	/	/	/	/
15		/	/	/	/	/	/	/	/	/	/	/
16		/	/	/	/	/	/	/	/	/	/	/
17		/	/	/	/	/	/	/	/	/	/	/
18		/	/	/	/	/	/	/	/	/	/	/
19		/	/	/	/	/	/	/	/	/	/	/
20		/	/	/	/	/	/	/	/	/	/	/
21		/	/	/	/	/	/	/	/	/	/	/
22		/	/	/	/	/	/	/	/	/	/	/
23		/	/	/	/	/	/	/	/	/	/	/
24		/	/	/	/	/	/	/	/	/	/	/
25		/	/	/	/	/	/	/	/	/	/	/
26		/	/	/	/	/	/	/	/	/	/	/
27		/	/	/	/	/	/	/	/	/	/	/
28		/	/	/	/	/	/	/	/	/	/	/
29		/	/	/	/	/	/	/	/	/	/	/
30		/	/	/	/	/	/	/	/	/	/	/
31		/	/	/	/	/	/	/	/	/	/	/
32		/	/	/	/	/	/	/	/	/	/	/
33		/	/	/	/	/	/	/	/	/	/	/
34		/	/	/	/	/	/	/	/	/	/	/
35		/	/	/	/	/	/	/	/	/	/	/
36	1	/	/	/	/	/	/	/	/	/	1/	2/ 1
37	12	/	/	/	/	1/	1/ 1	1/	2/ 1	2/ 1	5/ 2	1/ 1
38	12	/	/	/	/	/	/	1/ 1	1/ 1	2/ 1	8/ 2	1/ 1
39	4	/	/	/	/	/	/	/	/	3/ 2	1/	/
40		/	/	/	/	/	/	/	/	/	/	/
41		/	/	/	/	/	/	/	/	/	/	/
42		/	/	/	/	/	/	/	/	/	/	/
43		/	/	/	/	/	/	/	/	/	/	/
44		/	/	/	/	/	/	/	/	/	/	/
45		/	/	/	/	/	/	/	/	/	/	/
46		/	/	/	/	/	/	/	/	/	/	/
47		/	/	/	/	/	/	/	/	/	/	/
48		/	/	/	/	/	/	/	/	/	/	/
49		/	/	/	/	/	/	/	/	/	/	/
50		/	/	/	/	/	/	/	/	/	/	/
51	2	/	/	/	/	/	/	/	1/	/	1/	1/ 1
52		/	/	/	/	/	/	/	/	/	/	/
53		/	/	/	/	/	/	/	/	/	/	/
54	1	/	/	/	/	/	/	/	/	/	1/ 1	/
55	1	/	/	/	/	/	/	/	/	/	1/ 1	/
56		/	/	/	/	/	/	/	/	/	/	/
57		/	/	/	/	/	/	/	/	/	/	/
58		/	/	/	/	/	/	/	/	/	/	/
59		/	/	/	/	/	/	/	/	/	/	/
60		/	/	/	/	/	/	/	/	/	/	/

FIGURE B-2

SEC	MIN = 1?432 TOT	> 110	105-110	100-105	95-100	92-95	89-92	87-89	84-87	80-84	70-80	< 70
1		/	/	/	/	/	/	/	/	/	/	/
2		/	/	/	/	/	/	/	/	/	/	/
3		/	/	/	/	/	/	/	/	/	/	/
4	1	/	/	/	/	/	/	/	/	/	1/	/
5	1	/	/	/	/	/	/	/	/	1/	/	/
6	2	/	/	/	/	/	/	/	/	/	2/	/
7	2	/	/	/	/	/	/	1/	1/	/	/	/
8		/	/	/	/	/	/	/	/	/	/	/
9	3	/	/	/	/	/	/	/	1/	2/	/	/
10	7	/	/	/	/	/	/	/	1/	2/	4/	1/
11	3	/	/	/	/	/	/	1/	/	1/	1/	/
12	6	/	/	/	/	/	/	/	/	3/	3/	/
13		/	/	/	/	/	/	/	/	/	/	/
14		/	/	/	/	/	/	/	/	/	/	/
15		/	/	/	/	/	/	/	/	/	/	/
16		/	/	/	/	/	/	/	/	/	/	/
17		/	/	/	/	/	/	/	/	/	/	/
18		/	/	/	/	/	/	/	/	/	/	/
19		/	/	/	/	/	/	/	/	/	/	/
20		/	/	/	/	/	/	/	/	/	/	/
21		/	/	/	/	/	/	/	/	/	/	/
22		/	/	/	/	/	/	/	/	/	/	/
23		/	/	/	/	/	/	/	/	/	/	/
24		/	/	/	/	/	/	/	/	/	/	/
25	2	/	/	/	/	/	/	/	/	/	2/ 1	/
26		/	/	/	/	/	/	/	/	/	/	/
27	3	/	/	/	/	/	/	/	/	1/ 1	2/ 1	1/
28		/	/	/	/	/	/	/	/	/	/	/
29		/	/	/	/	/	/	/	/	/	/	/
30		/	/	/	/	/	/	/	/	/	/	/
31	2	/	/	/	/	/	/	/	/	2/ 1	/	/
32	3	/	/	/	/	/	/	/	/	1/	2/ 1	/
33		/	/	/	/	/	/	/	/	/	/	/
34		/	/	/	/	/	/	/	/	/	/	/
35	2	/	/	/	/	/	/	/	/	1/ 1	1/	/
36	2	/	/	/	/	/	/	/	/	1/	1/ 1	1/
37	5	/	/	/	/	/	1/ 1	/	/	1/ 1	3/ 1	1/
38	3	/	/	/	/	1/	/	/	/	/	2/ 1	/
39	2	/	/	/	/	/	/	/	1/	1/ 1	/	/
40		/	/	/	/	/	/	/	/	/	/	/
41		/	/	/	/	/	/	/	/	/	/	/
42	2	/	/	/	/	/	/	1/ 1	/	/	[illegible]	/
43	[illegible]	/	/	/	/	/	/	/	/	1/ 1	/	1/
44	2	/	/	/	/	/	/	/	/	/	2/ 1	/
45		/	/	/	/	/	/	/	/	/	/	/
46		/	/	/	/	/	/	/	/	/	/	/
47	1	/	/	/	/	/	/	/	1/ 1	/	/	/
48	1	/	/	/	/	/	/	/	/	1/	/	/
49		/	/	/	/	/	/	/	/	/	/	/
50		/	/	/	/	/	/	/	/	/	/	/
51	2	/	/	/	/	/	/	1/	/	1/	/	/
52		/	/	/	/	/	/	/	/	/	/	/
53		/	/	/	/	/	/	/	/	/	/	/
54	1	/	/	/	/	/	/	1/ 1	/	/	/	2/ 1
55		/	/	/	/	/	/	/	/	/	/	/
56		/	/	/	/	/	/	/	/	/	/	/
57		/	/	/	/	/	/	/	/	/	/	/
58		/	/	/	/	/	/	/	/	/	/	/
59	1	/	/	/	/	/	/	/	/	1/	/	/
60		/	/	/	/	/	/	/	/	/	/	/

AMPLITUDE IN DB

FIGURE B-3

	MIN. ...	AMPLITUDE IN DB										
SEC	TOT	> 110	[illegible]-110	100-105	95-100	92-95	89-92	87-89	84-87	80-84	70-80	< 70
1		/	/	/	/	/	/	/	/	/	/	/
2		/	/	/	/	/	/	/	/	/	/	/
3		/	/	/	/	/	/	/	/	/	/	/
4		/	/	/	/	/	/	/	/	/	/	/
5		/	/	/	/	/	/	/	/	/	/	/
6	2	/	/	/	/	/	/	/	1/	1/	/	/
7		/	/	/	/	/	/	/	/	/	/	/
8	2	/	/	/	1/	/	/	/	/	1/	/	/
9	2	/	/	/	/	/	/	/	/	/	2/	/
10	3	/	/	/	/	/	/	/	1/	/	2/	1/
11	2	/	/	/	/	/	1/	/	1/	/	/	1/
12	4	/	/	/	/	/	/	/	/	1/	3/	1/
13	3	/	/	/	/	/	/	/	/	3/	/	/
14	5	/	/	/	/	/	1/	/	2/	/	2/	/
15		/	/	/	/	/	/	/	/	/	/	/
16	2	/	/	/	/	/	/	/	/	1/	1/	/
17	1	/	/	/	/	/	/	/	1/ 1	/	/	1/
18		/	/	/	/	/	/	/	/	/	/	/
19		/	/	/	/	/	/	/	/	/	/	/
20		/	/	/	/	/	/	/	/	/	/	/
21		/	/	/	/	/	/	/	/	/	/	/
22		/	/	/	/	/	/	/	/	/	/	/
23		/	/	/	/	/	/	/	/	/	/	/
24		/	/	/	/	/	/	/	/	/	/	/
25		/	/	/	/	/	/	/	/	/	/	/
26		/	/	/	/	/	/	/	/	/	/	/
27	2	/	/	/	/	/	/	/	/	/	2/ 1	/
28		/	/	/	/	/	/	/	/	/	/	/
29	2	/	/	/	/	/	1/	/	/	/	1/ 1	/
30	2	/	/	/	/	/	/	1/ 1	/	1/	/	/
31	1	/	/	/	/	/	/	/	/	1/ 1	/	1/
32	4	/	/	/	/	/	/	/	/	3/	1/ 1	/
33	2	/	/	/	/	/	/	/	/	/	2/ 1	/
34		/	/	/	/	/	/	/	/	/	/	/
35		/	/	/	/	/	/	/	/	/	/	/
36	2	/	/	/	/	/	/	/	/	/	2/ 1	/
37		/	/	/	/	/	/	/	/	/	/	/
38	2	/	/	/	/	/	1/	/	/	/	1/ 1	/
39		/	/	/	/	/	/	/	/	/	/	/
40		/	/	/	/	/	/	/	/	/	/	/
41		/	/	/	/	/	/	/	/	/	/	/
42	2	/	/	/	/	/	/	/	/	/	2/ 1	/
43	2	/	/	/	/	/	/	/	/	/	2/ 1	/
44	3	/	/	/	/	/	/	/	1/	/	2/ 1	1/ 1
45		/	/	/	/	/	/	/	/	/	/	/
46	1	/	/	/	/	/	/	/	/	/	1/ 1	1/
47		/	/	/	/	/	/	/	/	/	/	1/ 1
48	2	/	/	/	/	/	1/	1/ 1	/	/	/	1/
49	1	/	/	/	/	/	/	/	/	/	1/ 1	1/
50	1	/	/	/	/	/	/	/	/	/	1/ 1	/
51		/	/	/	/	/	/	/	/	/	/	/
52		/	/	/	/	/	/	/	/	/	/	/
53		/	/	/	/	/	/	/	/	/	/	/
54		/	/	/	/	/	/	/	/	/	/	/
55		/	/	/	/	/	/	/	/	/	/	/
56		/	/	/	/	/	/	/	/	/	/	/
57		/	/	/	/	/	/	/	/	/	/	/
58		/	/	/	/	/	/	/	/	/	/	/
59		/	/	/	/	/	/	/	/	/	/	/
60		/	/	/	/	/	/	/	/	/	/	/

FIGURE B-4

MIN = 10434 — A M P L I T U D E I N D B

SEC	TOT	> 110	105-110	100-105	95-100	92-95	89-92	87-89	84-87	80-84	70-80	< 70
1		/	/	/	/	/	/	/	/	/	/	/
2		/	/	/	/	/	/	/	/	/	/	/
3		/	/	/	/	/	/	/	/	/	/	/
4	1	/	/	/	/	1/ 1	/	/	/	/	/	/
5		/	/	/	/	/	/	/	/	/	/	/
6	2	/	/	/	/	1/	/	1/	/	/	/	/
7		/	/	/	/	/	/	/	/	/	/	/
8	2	/	/	/	/	/	/	1/	1/	/	/	/
9	2	/	/	/	/	/	1/	/	/	1/	/	2/ 1
10	4	/	/	/	/	/	/	/	1/	1/	2/	/
11	2	/	/	/	/	/	/	1/	/	/	1/	/
12	6	/	/	/	/	1/	/	/	3/	/	2/	/
13	2	/	/	/	/	/	/	/	/	/	2/	/
14	7	/	/	/	/	1/	/	2/	/	/	4/ 1	1/
15	2	/	/	/	/	/	/	/	/	2/	/	/
16	1	/	/	/	1/	/	/	/	/	/	/	/
17	1	/	/	/	/	/	/	/	/	/	1/	/
18	2	/	/	/	1/	/	/	/	/	1/	/	/
19	4	/	/	/	/	/	1/	/	1/ 1	1/	1/	/
20	3	/	/	/	/	/	/	1/	/	1/	1/	1/
21		/	/	/	/	/	/	/	/	/	/	/
22		/	/	/	/	/	/	/	/	/	/	/
23		/	/	/	/	/	/	/	/	/	/	/
24	2	/	/	/	1/	/	/	/	/	/	1/ 1	2/ 1
25		/	/	/	/	/	/	/	/	/	/	/
26	2	/	/	/	/	/	/	/	/	1/ 1	1/	/
27	2	/	/	/	/	/	/	/	1/ 1	/	1/	/
28		/	/	/	/	/	/	/	/	/	/	/
29		/	/	/	/	/	/	/	/	/	/	/
30	4	/	/	/	/	/	/	/	/	2/ 1	2/ 1	/
31		/	/	/	/	/	/	/	/	/	/	/
32		/	/	/	/	/	/	/	/	/	/	/
33		/	/	/	/	/	/	/	/	/	/	/
34	1	/	/	/	/	/	/	/	/	1/ 1	/	1/
35	2	/	/	/	/	/	1/ 1	/	/	/	1/	/
36	2	/	/	/	/	/	/	/	/	1/	1/ 1	/
37		/	/	/	/	/	/	/	/	/	/	/
38	2	/	/	/	/	/	/	1/ 1	/	/	1/	/
39		/	/	/	/	/	/	/	/	/	/	/
40		/	/	/	/	/	/	/	/	/	/	/
41		/	/	/	/	/	/	/	/	/	/	/
42	3	/	/	/	/	/	1/	/	/	/	2/ 2	1/
43		/	/	/	/	/	/	/	/	/	/	/
44	1	/	/	/	/	/	/	/	/	1/	/	/
45		/	/	/	/	/	/	/	/	/	/	/
46		/	/	/	/	/	/	/	/	/	/	/
47		/	/	/	/	/	/	/	/	/	/	/
48		/	/	/	/	/	/	/	/	/	/	/
49		/	/	/	/	/	/	/	/	/	/	/
50	2	/	/	/	/	/	/	/	/	/	2/ 1	/
51		/	/	/	/	/	/	/	/	/	/	/
52		/	/	/	/	/	/	/	/	/	/	/
53		/	/	/	/	/	/	/	/	/	/	/
54	2	/	/	/	/	/	/	/	/	1/ 1	1/	/
55		/	/	/	/	/	/	/	/	/	/	/
56		/	/	/	/	/	/	/	/	/	/	/
57	2	/	/	/	1/	/	/	/	/	1/ 1	/	/
58		/	/	/	/	/	/	/	/	/	/	/
59		/	/	/	/	/	/	/	/	/	/	/
60	1	/	/	/	/	/	/	/	/	/	1/ 1	/

FIGURE B-5

SEC	MIN = 1042 TOT	> 110	105-110	100-105	AMPLITUDE 95-100	92-95	IN 89-92	DB 87-89	84-87	80-84	70-80	< 70
1		/	/	/	/	/	/	/	/	/	/	/
2		/	/	/	/	/	/	/	/	/	/	/
3		/	/	/	/	/	/	/	/	/	/	/
4		/	/	/	/	/	/	/	/	/	/	/
5		/	/	/	/	/	/	/	/	/	/	/
6	2	/	/	/	/	/	/	/	/	1/	1/	/
7		/	/	/	/	/	/	/	/	/	/	/
8	2	/	/	/	/	1/	/	/	/	/	1/	/
9	1	/	/	/	/	/	1/	/	/	/	/	1/
10	2	/	/	/	/	/	/	/	/	/	2/	/
11		/	/	/	/	/	/	/	/	/	/	/
12	5	/	/	/	1/	/	/	/	1/	1/	2/	1/
13		/	/	/	/	/	/	/	/	/	/	/
14	6	/	/	/	/	1/	/	/	/	3/ 1	2/	/
15	1	/	/	/	/	/	/	/	1/	/	/	1/
16		/	/	/	/	/	/	/	/	/	/	/
17	2	/	/	/	/	/	/	/	/	2/	/	/
18		/	/	/	/	/	/	/	/	/	/	/
19	2	/	/	/	/	/	/	/	/	/	2/	/
20	1	/	/	/	/	/	/	/	/	/	1/	/
21	1	/	/	/	/	/	/	/	/	1/	/	1/
22		/	/	/	/	/	/	/	/	/	/	/
23		/	/	/	/	/	/	/	/	/	/	/
24		/	/	/	/	/	/	/	/	/	/	/
25		/	/	/	/	/	/	/	/	/	/	/
26		/	/	/	/	/	/	/	/	/	/	/
27	3	/	/	/	/	/	1/	/	/	1/	1/ 1	1/ 1
28	1	/	/	/	/	/	/	/	/	/	1/	/
29		/	/	/	/	/	/	/	/	/	/	/
30		/	/	/	/	/	/	/	/	/	/	/
31		/	/	/	/	/	/	/	/	/	/	/
32	4	/	/	/	/	1/ 1	/	1/ 1	/	/	2/	/
33	1	/	/	/	/	/	1/ 1	/	/	/	/	1/
34		/	/	/	/	/	/	/	/	/	/	/
35		/	/	/	/	/	/	/	/	/	/	1/
36	2	/	/	/	/	/	/	/	/	1/ 1	1/	/
37		/	/	/	/	/	/	/	/	/	/	/
38	2	/	/	/	/	/	/	/	/	/	2/ 2	1/
39	2	/	/	/	/	/	/	/	/	1/ 1	1/	/
40	3	/	/	/	/	/	/	/	1/	/	2/ 1	/
41	2	/	/	/	1/ 1	/	/	/	/	1/ 1	/	2/
42		/	/	/	/	/	/	/	/	/	/	/
43	1	/	/	/	/	/	/	/	/	/	1/ 1	/
44		/	/	/	/	/	/	/	/	/	/	/
45		/	/	/	/	/	/	/	/	/	/	/
46		/	/	/	/	/	/	/	/	/	/	/
47		/	/	/	/	/	/	/	/	/	/	/
48		/	/	/	/	/	/	/	/	/	/	/
49		/	/	/	/	/	/	/	/	/	/	2/ 1
50	1	/	/	/	/	/	/	/	/	/	1/ 1	/
51		/	/	/	/	/	/	/	/	/	/	/
52		/	/	/	/	/	/	/	/	/	/	/
53		/	/	/	/	/	/	/	/	/	/	/
54		/	/	/	/	/	/	/	/	/	/	/
55		/	/	/		/	/	/	/	/	/	/
56	3	/	/	/	/	/	/	/	1/	1/ 1	1/ 1	2/ 1
57		/	/	/	/	/	/	/	/	/	/	/
58		/	/	/	/	/	/	/	/	/	/	/
59	2	/	/	/	/	/	/	1/ 1	/	1/	/	/
60	2	/	/	/	/	/	/	/	/	/	2/ 1	/

FIGURE B-6

SEC	MIN = 13436 TOT	AMPLITUDE IN DB > 110	105-110	100-105	95-100	92-95	89-92	87-89	84-87	80-84	70-80	< 70
1		/	/	/	/	/	/	/	/	/	/	/
2		/	/	/	/	/	/	/	/	/	/	/
3		/	/	/	/	/	/	/	/	/	/	/
4		/	/	/	/	/	/	/	/	/	/	/
5		/	/	/	/	/	/	/	/	/	/	/
6	2	/	/	1/	/	/	/	/	/	1/	/	/
7		/	/	/	/	/	/	/	/	/	/	/
8	2	/	/	/	/	/	/	/	1/	1/	/	/
9	2	/	/	/	/	/	/	/	/	1/	1/	/
10	3	/	/	/	/	/	1/	/	/	/	2/	1/
11		/	/	/	/	/	/	/	/	/	/	/
12	4	/	/	/	/	/	/	1/	1/	/	2/	2/
13		/	/	/	/	/	/	/	/	/	/	/
14	2	/	/	/	/	/	1/	/	/	1/	/	/
15	2	/	/	/	/	/	/	/	/	1/	1/	/
16		/	/	/	/	/	/	/	/	/	/	/
17	2	/	/	/	/	/	/	/	/	1/	1/	/
18	1	/	/	/	/	/	/	/	1/	/	/	1/
19	5	/	/	/	/	/	/	/	/	1/	4/ 1	/
20		/	/	/	/	/	/	/	/	/	/	/
21	2	/	/	/	/	/	/	/	/	/	2/	/
22	2	/	/	/	/	/	/	/	/	1/ 1	1/	/
23		/	/	/	/	/	/	/	/	/	/	/
24		/	/	/	/	/	/	/	/	/	/	/
25	2	/	/	/	/	/	/	/	/	1/	1/ 1	/
26		/	/	/	/	/	/	/	/	/	/	/
27		/	/	/	/	/	/	/	/	/	/	/
28		/	/	/	/	/	/	/	/	/	/	/
29	2	/	/	/	/	/	/	/	/	/	2/ 1	/
30		/	/	/	/	/	/	/	/	/	/	/
31	2	/	/	/	/	/	/	/	/	/	2/ 1	/
32		/	/	/	/	/	/	/	/	/	/	/
33	3	/	/	/	/	/	/	/	/	/	3/ 1	/
34		/	/	/	/	/	/	/	/	/	/	/
35	1	/	/	/	/	/	/	/	/	1/	/	/
36		/	/	/	/	/	/	/	/	/	/	2/ 1
37	1	/	/	/	/	/	/	/	/	/	1/ 1	/
38		/	/	/	/	/	/	/	/	/	/	/
39		/	/	/	/	/	/	/	/	/	/	/
40		/	/	/	/	/	/	/	/	/	/	/
41	5	/	/	/	/	/	1/ 1	/	/	1/ 1	3/ 1	1/
42		/	/	/	/	/	/	/	/	/	/	/
43		/	/	/	/	/	/	/	/	/	/	/
44		/	/	/	/	/	/	/	/	/	/	/
45		/	/	/	/	/	/	/	/	/	/	/
46		/	/	/	/	/	/	/	/	/	/	/
47		/	/	/	/	/	/	/	/	/	/	/
48		/	/	/	/	/	/	/	/	/	/	/
49	1	/	/	/	/	/	/	/	/	/	1/ 1	/
50	3	/	/	/	/	/	/	/	/	/	3/ 2	/
51		/	/	/	/	/	/	/	/	/	/	/
52		/	/	/	/	/	/	/	/	/	/	/
53	2	/	/	/	/	/	1/ 1	/	1/	/	/	/
54		/	/	/	/	/	/	/	/	/	/	/
55		/	/	/	/	/	/	/	/	/	/	/
56	2	/	/	/	/	/	/	/	2/ 1	/	/	/
57		/	/	/	/	/	/	/	/	/	/	/
58		/	/	/	/	/	/	/	/	/	/	/
59		/	/	/	/	/	/	/	/	/	/	/
60		/	/	/	/	/	/	/	/	/	/	/

FIGURE B-7

MIN = 11437 AMPLITUDE IN DB

SEC	TOT	> 110	105-110	100-105	95-100	92-95	89-92	87-89	84-87	80-84	70-80	< 70
1		/	/	/	/	/	/	/	/	/	/	/
2		/	/	/	/	/	/	/	/	/	/	/
3	1	/	/	/	/	/	/	/	1/ 1	/	/	1/
4	2	/	/	/	1/ 1	/	/	/	/	1/	/	/
5		/	/	/	/	/	/	/	/	/	/	/
6	2	/	/	/	/	/	/	/	/	1/	1/	/
7		/	/	/	/	/	/	/	/	/	/	/
8	2	/	/	/	/	/	/	/	1/	/	1/	/
9	1	/	/	/	/	/	/	/	/	/	1/	1/
10	4	/	/	/	/	/	/	/	1/	/	3/ 1	/
11		/	/	/	/	/	/	/	/	/	/	/
12	7	/	/	/	/	/	/	/	3/ 1	2/	2/	1/
13		/	/	/	/	/	/	/	/	/	/	/
14	1	/	/	/	/	/	/	/	/	/	1/	1/
15	2	/	/	/	/	/	/	/	/	1/	1/	/
16		/	/	/	/	/	/	/	/	/	/	/
17	2	/	/	/	/	/	/	/	2/	/	/	2/
18		/	/	/	/	/	/	/	/	/	/	/
19	2	/	/	/	1/	/	/	/	1/	/	/	/
20		/	/	/	/	/	/	/	/	/	/	/
21	3	/	/	/	/	/	/	/	/	1/	2/ 1	1/
22	2	/	/	/	/	/	/	/	1/	/	1/ 1	/
23	2	/	/	/	/	/	/	/	/	/	2/ 1	1/
24		/	/	/	/	/	/	/	/	/	/	/
25		/	/	/	/	/	/	/	/	/	/	/
26	1	/	/	/	/	/	/	/	/	1/	/	1/ 1
27		/	/	/	/	/	/	/	/	/	/	/
28		/	/	/	/	/	/	/	/	/	/	/
29		/	/	/	/	/	/	/	/	/	/	/
30		/	/	/	/	/	/	/	/	/	/	/
31	1	/	/	/	/	/	/	/	1/ 1	/	/	1/
32	3	/	/	/	/	/	/	/	1/ 1	1/	1/	1/ 1
33		/	/	/	/	/	/	/	/	/	/	/
34		/	/	/	/	/	/	/	/	/	/	/
35		/	/	/	/	/	/	/	/	/	/	/
36		/	/	/	/	/	/	/	/	/	/	/
37		/	/	/	/	/	/	/	/	/	/	/
38		/	/	/	/	/	/	/	/	/	/	/
39		/	/	/	/	/	/	/	/	/	/	/
40	1	/	/	/	/	/	/	/	/	/	1/	/
41	1	/	/	/	/	/	/	/	/	/	1/ 1	/
42		/	/	/	/	/	/	/	/	/	/	/
43	2	/	/	/	/	/	/	/	/	/	2/ 2	2/
44		/	/	/	/	/	/	/	/	/	/	/
45		/	/	/	/	/	/	/	/	/	/	/
46		/	/	/	/	/	/	/	/	/	/	/
47	1	/	/	/	/	/	/	/	/	1/ 1	/	1/
48	2	/	/	/	/	/	/	/	1/ 1	1/	/	/
49		/	/	/	/	/	/	/	/	/	/	/
50		/	/	/	/	/	/	/	/	/	/	/
51	2	/	/	/	/	/	1/ 1	/	/	/	1/	/
52		/	/	/	/	/	/	/	/	/	/	/
53		/	/	/	/	/	/	/	/	/	/	/
54		/	/	/	/	/	/	/	/	/	/	/
55	1	/	/	/	/	/	/	/	/	1/ 1	/	/
56	1	/	/	/	/	/	/	1/ 1	/	/	/	1/
57	2	/	/	/	/	/	/	/	1/ 1	1/	/	/
58		/	/	/	/	/	/	/	/	/	/	/
59		/	/	/	/	/	/	/	/	/	/	/
60		/	/	/	/	/	/	/	/	/	/	/

FIGURE B-8

	MIN = 1[illegible]434				A M P L I T U D E		I N	D B				
SEC	TOT	> 110	105-110	100-105	95-100	92-95	89-92	87-89	84-87	80-84	70-80	< 70
1	1	/	/	/	/	/	/	/	/	/	1/	1/
2		/	/	/	/	/	/	/	/	/	/	/
3		/	/	/	/	/	/	/	/	/	/	/
4	1	/	/	/	/	/	/	/	/	1/ 1	/	1/
5		/	/	/	/	/	/	/	/	/	/	/
6	2	/	/	/	/	/	/	/	/	1/	1/	/
7		/	/	/	/	/	/	/	/	/	/	/
8	1	/	/	/	/	/	/	1/	/	/	/	1/
9	1	/	/	/	/	/	/	/	/	/	1/	/
10	6	/	/	/	/	/	/	1/ 1	/	3/	2/	1/
11		/	/	/	/	/	/	/	/	/	/	/
12	4	/	/	/	/	/	/	/	1/	/	3/	2/ 1
13		/	/	/	/	/	/	/	/	/	/	/
14	2	/	/	/	/	/	/	1/	/	1/	/	2/
15	2	/	/	/	/	/	/	/	/	1/	1/	/
16	2	/	/	/	/	/	/	/	/	1/ 1	1/	/
17	4	/	/	/	/	/	1/	/	/	/	3/	/
18		/	/	/	/	/	/	/	/	/	/	/
19	1	/	/	/	/	/	/	/	/	/	1/	1/
20	1	/	/	/	/	/	/	/	/	/	1/	1/ 1
21	2	/	/	/	/	/	/	/	/	/	2/	/
22		/	/	/	/	/	/	/	/	/	/	/
23		/	/	/	/	/	/	/	/	/	/	/
24		/	/	/	/	/	/	/	/	/	/	/
25		/	/	/	/	/	/	/	/	/	/	/
26	2	/	/	/	/	/	/	/	1/	/	1/ 1	/
27		/	/	/	/	/	/	/	/	/	/	/
28	2	/	/	/	/	/	/	/	/	/	2/	/
29		/	/	/	/	/	/	/	/	/	/	/
30		/	/	/	/	/	/	/	/	/	/	/
31	1	/	/	/	/	/	/	/	/	/	1/ 1	1/
32	2	/	/	/	/	/	/	/	/	/	2/ 1	/
33		/	/	/	/	/	/	/	/	/	/	/
34		/	/	/	/	/	/	/	/	/	/	/
35		/	/	/	/	/	/	/	/	/	/	/
36	2	/	/	/	/	/	1/ 1	/	/	/	1/	/
37		/	/	/	/	/	/	/	/	/	/	/
38		/	/	/	/	/	/	/	/	/	/	/
39		/	/	/	/	/	/	/	/	/	/	/
40		/	/	/	/	/	/	/	/	/	/	/
41		/	/	/	/	/	/	/	/	/	/	/
42	1	/	/	/	/	/	/	/	/	1/	/	1/ 1
43		/	/	/	/	/	/	/	/	/	/	/
44	2	/	/	/	/	/	/	/	/	/	2/ 1	/
45		/	/	/	/	/	/	/	/	/	/	/
46	4	/	/	/	/	/	/	1/ 1	1/ 1	/	2/	/
47		/	/	/	/	/	/	/	/	/	/	/
48		/	/	/	/	/	/	/	/	/	/	/
49		/	/	/	/	/	/	/	/	/	/	/
50		/	/	/	/	/	/	/	/	/	/	/
51		/	/	/	/	/	/	/	/	/	/	/
52		/	/	/	/	/	/	/	/	/	/	/
53		/	/	/	/	/	/	/	/	/	/	/
54		/	/	/	/	/	/	/	/	/	/	/
55		/	/	/	/	/	/	/	/	/	/	/
56	1	/	/	/	/	/	/	/	/	/	1/	1/ 1
57	1	/	/	/	/	/	/	/	/	/	1/	/
58	4	/	/	/	/	/	/	/	/	1/ 1	3/ 1	1/
59		/	/	/	/	/	/	/	/	/	/	1/ 1
60		/	/	/	/	/	/	/	/	/	/	/

FIGURE B-9

	MIN = 1043[illegible]					AMPLITUDE IN DB						
SEC	TOT	> 110	105-110	100-105	95-100	92-95	89-92	87-89	84-87	80-84	70-80	< 70
1		/	/	/	/	/	/	/	/	/	/	/
2		/	/	/	/	/	/	/	/	/	/	/
3	2	/	/	/	/	/	/	/	/	/	2/ 1	/
4	1	/	/	/	/	/	/	/	/	1/ 1	/	/
5		/	/	/	/	/	/	/	/	/	/	/
6	2	/	/	/	/	/	1/	/	/	1/	/	/
7		/	/	/	/	/	/	/	/	/	/	/
8	2	/	/	/	/	/	/	/	2/	/	/	/
9		/	/	/	/	/	/	/	/	/	/	/
10	4	/	/	/	/	1/ 1	/	1/	/	/	2/	/
11		/	/	/	/	/	/	/	/	/	/	/
12	2	/	/	/	/	/	/	/	/	/	2/	/
13	2	/	/	/	/	/	/	/	1/	1/	/	/
14	3	/	/	/	/	1/	/	/	/	/	2/ 1	1/
15	2	/	/	/	/	/	/	/	1/	/	1/	/
16		/	/	/	/	/	/	/	/	/	/	/
17	4	/	/	/	/	/	/	/	/	1/	3/	2/ 1
18		/	/	/	/	/	/	/	/	/	/	/
19	1	/	/	/	/	/	/	/	/	/	1/	1/
20		/	/	/	/	/	/	/	/	/	/	/
21	2	/	/	/	/	/	/	/	/	/	2/	/
22		/	/	/	/	/	/	/	/	/	/	/
23		/	/	/	/	/	/	/	/	/	/	/
24	2	/	/	/	/	/	/	/	/	2/ 1	/	/
25	2	/	/	/	/	/	/	/	/	/	2/ 1	/
26		/	/	/	/	/	/	/	/	/	/	/
27		/	/	/	/	/	/	/	/	/	/	/
28	2	/	/	/	/	/	/	/	/	/	2/ 1	/
29	1	/	/	/	/	/	/	/	/	1/	/	/
30	2	/	/	/	/	/	1/ 1	/	1/	/	/	/
31	10	/	/	1/	/	/	/	/	1/ 1	2/ 1	6/ 3	2/ 1
32	7	/	/	/	/	1/	1/ 1	/	3/ 2	/	2/	3/ 1
33	6	/	/	/	/	/	1/	2/ 1	/	/	3/ 2	3/ 1
34	1	/	/	/	/	/	/	/	/	/	1/ 1	1/
35		/	/	/	/	/	/	/	/	/	/	/
36		/	/	/	/	/	/	/	/	/	/	/
37		/	/	/	/	/	/	/	/	/	/	/
38		/	/	/	/	/	/	/	/	/	/	/
39		/	/	/	/	/	/	/	/	/	/	/
40		/	/	/	/	/	/	/	/	/	/	/
41		/	/	/	/	/	/	/	/	/	/	/
42		/	/	/	/	/	/	/	/	/	/	/
43		/	/	/	/	/	/	/	/	/	/	/
44		/	/	/	/	/	/	/	/	/	/	/
45	1	/	/	/	/	/	/	/	/	/	1/ 1	/
46		/	/	/	/	/	/	/	/	/	/	/
47		/	/	/	/	/	/	/	/	/	/	/
48		/	/	/	/	/	/	/	/	/	/	/
49		/	/	/	/	/	/	/	/	/	/	/
50		/	/	/	/	/	/	/	/	/	/	/
51		/	/	/	/	/	/	/	/	/	/	/
52	1	/	/	/	/	/	/	/	/	/	1/	1/
53		/	/	/	/	/	/	/	/	/	/	/
54		/	/	/	/	/	/	/	/	/	/	/
55		/	/	/	/	/	/	/	/	/	/	/
56		/	/	/	/	/	/	/	/	/	/	/
57		/	/	/	/	/	/	/	/	/	/	/
58		/	/	/	/	/	/	/	/	/	/	/
59		/	/	/	/	/	/	/	/	/	/	/
60		/	/	/	/	/	/	/	/	/	/	1/ 1

FIGURE B-10

MIP = 12440 AMPLITUDE IN DB

SEC	TOT	> 110	105-110	100-105	95-100	92-95	89-92	87-89	84-87	80-84	70-80	< 70
1		/	/	/	/	/	/	/	/	/	/	/
2		/	/	/	/	/	/	/	/	/	/	1/ 1
3		/	/	/	/	/	/	/	/	/	/	/
4		/	/	/	/	/	/	/	/	/	/	/
5	1	/	/	/	/	/	/	/	/	/	1/ 1	/
6	2	/	/	/	/	/	/	1/	/	1/	/	/
7		/	/	/	/	/	/	/	/	/	/	/
8	2	/	/	/	/	/	/	/	/	1/	1/	/
9		/	/	/	/	/	/	/	/	/	/	/
10	2	/	/	/	/	/	/	/	1/	/	1/	/
11		/	/	/	/	/	/	/	/	/	/	/
12	2	/	/	/	/	/	/	/	1/	/	1/	/
13		/	/	/	/	/	/	/	/	/	/	/
14		/	/	/	/	/	/	/	/	/	/	/
15	4	/	/	/	/	/	/	/	/	1/	3/	/
16		/	/	/	/	/	/	/	/	/	/	/
17	4	/	/	/	/	/	/	/	/	3/	1/	/
18		/	/	/	/	/	/	/	/	/	/	/
19	1	/	/	/	/	/	1/	/	/	/	/	1/
20		/	/	/	/	/	/	/	/	/	/	/
21	1	/	/	/	/	/	/	/	/	/	1/	1/
22		/	/	/	/	/	/	/	/	/	/	/
23		/	/	/	/	/	/	/	/	/	/	/
24	4	/	/	/	/	/	2/ 2	1/	/	/	1/	/
25	2	/	/	/	/	1/ 1	/	/	/	/	1/	/
26	4	/	/	/	/	/	1/ 1	/	/	1/ 1	2/	/
27	2	/	/	/	/	/	/	1/ 1	/	/	1/	1/
28	2	/	/	/	/	/	/	1/ 1	/	/	1/	/
29	2	/	/	/	/	1/	/	/	/	/	1/ 1	/
30	3	/	/	/	/	/	/	/	/	/	3/ 2	1/
31	5	/	/	/	/	/	/	/	1/ 1	3/ 2	1/	2/
32		/	/	/	/	/	/	/	/	/	/	/
33		/	/	/	/	/	/	/	/	/	/	/
34	1	/	/	/	/	/	/	/	/	1/ 1	/	1/
35		/	/	/	/	/	/	/	/	/	/	/
36	1	/	/	/	/	/	1/ 1	/	/	/	/	1/
37		/	/	/	/	/	/	/	/	/	/	/
38		/	/	/	/	/	/	/	/	/	/	/
39		/	/	/	/	/	/	/	/	/	/	1/
40		/	/	/	/	/	/	/	/	/	/	/
41		/	/	/	/	/	/	/	/	/	/	/
42		/	/	/	/	/	/	/	/	/	/	/
43		/	/	/	/	/	/	/	/	/	/	/
44		/	/	/	/	/	/	/	/	/	/	/
45		/	/	/	/	/	/	/	/	/	/	/
46		/	/	/	/	/	/	/	/	/	/	/
47		/	/	/	/	/	/	/	/	/	/	/
48		/	/	/	/	/	/	/	/	/	/	/
49		/	/	/	/	/	/	/	/	/	/	/
50		/	/	/	/	/	/	/	/	/	/	/
51		/	/	/	/	/	/	/	/	/	/	/
52		/	/	/	/	/	/	/	/	/	/	/
53		/	/	/	/	/	/	/	/	/	/	/
54		/	/	/	/	/	/	/	/	/	/	/
55		/	/	/	/	/	/	/	/	/	/	/
56		/	/	/	/	/	/	/	/	/	/	/
57	1	/	/	/	/	/	/	1/ 1	/	/	/	/
58		/	/	/	/	/	/	/	/	/	/	/
59		/	/	/	/	/	/	/	/	/	/	/
60		/	/	/	/	/	/	/	/	/	/	/

FIGURE B-11

FIGURE B-12

TOT EVENTS	RED MUZZLES
0	0.00
1	.56
2	.55
3	.94
4	1.12
5	1.20
6	1.00
7	2.00
8	.67
9	4.00
10	4.00
11	0.00
12	6.00
13	6.00
14	0.00
15	0.00
16	0.00
17	0.00
18	0.00
19	0.00
20	0.00
21	0.00
22	0.00
23	0.00
24	0.00
25	0.00
26	0.00
27	0.00
28	0.00
29	0.00
30	0.00
31	0.00
32	0.00
33	0.00
34	0.00
35	0.00
36	0.00
37	0.00
38	0.00
39	0.00
40	0.00
41	0.00
42	0.00
43	0.00
44	0.00
45	0.00
46	0.00
47	0.00
48	0.00
49	0.00
50	0.00
51	0.00
52	0.00
53	0.00
54	0.00
55	0.00
56	0.00
57	0.00
58	0.00
59	0.00
60	0.00
61	0.00
62	0.00
63	0.00
64	0.00
65	0.00
66	0.00
67	0.00
68	0.00
69	0.00
70	0.00
71	0.00
72	0.00
73	0.00
74	0.00
75	0.00
76	0.00
77	0.00
78	0.00
79	0.00
80	0.00
81	0.00
82	0.00
83	0.00
84	0.00
85	0.00
86	0.00
87	0.00
88	0.00
89	0.00
90	0.00
91	0.00
92	0.00
93	0.00
94	0.00
95	0.00
96	0.00
97	0.00
98	0.00
99	0.00

Copy available to DTIC does not permit fully legible reproduction

MIN OF GAME	NO. OF TGTS
1	0
2	0
3	0
4	0
5	0
6	53
7	81
8	76
9	51
10	33
11	19

FIGURE B-13

MIN OF GAME	NO. OF UNIQUE TGTS
1	0
2	0
3	0
4	0
5	0
6	3
7	0
8	0
9	0
10	1
11	2

FIGURE B-14

TROF	0	1	2	3	4	5	6	LOST	TOT
0- 25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25- 50	22.50	18.89	14.44	8.33	2.22	0.00	0.00	20.44	95.83
50- 75	0.00	.28	2.50	[illegible]	0.00	[illegible]	[illegible]	[illegible]	4.17
75- 100	0.00	0.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.00
100- 125	0.00	0.00	0.00	0.00	[illegible]	[illegible]	[illegible]	[illegible]	0.00
125- 150	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
150- 175	0.00	0.00	0.00	[illegible]	0.00	[illegible]	0.00	[illegible]	0.00
175- 200	0.00	0.00	0.00	[illegible]	[illegible]	[illegible]	[illegible]	0.00	0.00
200- 225	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
225- 250	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250- 275	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
275- 300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
300- 325	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
325- 350	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
350- 375	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
375- 400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
400- 425	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
425- 450	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
450- 475	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
475- 500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
500- 525	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
525- 550	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
550- 575	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
575- 600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
600- 625	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
625- 650	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650- 675	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
675- 700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
700- 725	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
725- 750	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
750- 775	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
775- 800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
800- 825	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
825- 850	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
850- 875	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
875- 900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
900- 925	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
925- 950	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
950- 975	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
975-1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1000-1025	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1025-1050	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1050-1075	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1075-1100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1100-1125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1125-1150	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1150-1175	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1175-1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1200-1225	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1225-1250	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1250-1275	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1275-1300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1300-1325	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1325-1350	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1350-1375	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FIGURE B-15

1375-1400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1400-1425	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1425-1450	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1450-1475	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1475-1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1500-1525	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1525-1550	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1550-1575	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1575-1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1600-1625	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1625-1650	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1650-1675	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1675-1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1700-1725	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1725-1750	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1750-1775	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1775-1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1800-1825	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1825-1850	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1850-1875	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1875-1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1900-1925	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1925-1950	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1950-1975	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1975-2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TOT = 100.0000

FIGURE B-15

Copy available to DTIC does not
permit fully legible reproduction

TROF	0	1	2	3	4	5	6	LOST	TOT
0- 25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25- 50	23.48	19.71	15.07	8.70	2.32	0.00	0.00	30.72	100.00
50- 75	0.00	6.67	60.00	0.00	0.00	0.00	0.00	33.33	100.00
75- 100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100- 125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125- 150	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
150- 175	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
175- 200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
200- 225	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
225- 250	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250- 275	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
275- 300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
300- 325	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
325- 350	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
350- 375	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
375- 400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
400- 425	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
425- 450	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
450- 475	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
475- 500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
500- 525	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
525- 550	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
550- 575	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
575- 600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
600- 625	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
625- 650	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
650- 675	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
675- 700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
700- 725	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
725- 750	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
750- 775	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
775- 800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
800- 825	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
825- 850	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
850- 875	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
875- 900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
900- 925	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
925- 950	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
950- 975	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
975-1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1000-1025	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1025-1050	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1050-1075	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1075-1100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1100-1125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1125-1150	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1150-1175	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1175-1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1200-1225	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1225-1250	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1250-1275	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1275-1300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1300-1325	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1325-1350	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FIGURE B-16

Copy a... not permit fully legible reproduction

1350-1375	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1375-1400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1400-1425	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1425-1450	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1450-1475	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1475-1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1500-1525	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1525-1550	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1550-1575	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1575-1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1600-1625	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1625-1650	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1650-1675	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1675-1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1700-1725	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1725-1750	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1750-1775	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1775-1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1800-1825	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1825-1850	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1850-1875	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1875-1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1900-1925	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1925-1950	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1950-1975	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1975-2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FIGURE B-16

Copy ... does not permit fully legible reproduction

FIGURE B-17

ROF		PRCNT OF GAME
0-	25	0.0000
25-	50	100.0000
50-	75	0.0000
75-	100	0.0000
100-	125	0.0000
125-	150	0.0000
150-	175	0.0000
175-	200	0.0000
200-	225	0.0000
225-	250	0.0000
250-	275	0.0000
275-	300	0.0000
300-	325	0.0000
325-	350	0.0000
350-	375	0.0000
375-	400	0.0000
400-	425	0.0000
425-	450	0.0000
450-	475	0.0000
475-	500	0.0000
500-	525	0.0000
525-	550	0.0000
550-	575	0.0000
575-	600	0.0000
600-	625	0.0000
625-	650	0.0000

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APPENDIX C

PROGRAM LISTING

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```
      PROGRAM SKEM(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,DEBUG=OUTPUT)
      IMPLICIT INTEGER (A-Z)
      REAL B
      COMMON/BLK1/MISHUN(60)/BLK2/ESNDBS,NSNDBS/BLK7/NC/BLK9/MASTIM
       COMMON / BLK12/CT,SYS,ROF
      DIMENSION ARTIL(9)
      DATA ESNDBS/2460/
     *     ,NSNDBS/2230/
     *     ,MASTIM/10430/
     *    ,MAXTIM/10441/
     *     ,CT     / 6/
     *     ,SYS    /1/
     *     ,ROF    /25/
C
C     TYP  = 1 - 155MM HOWITZER-------21
C          = 2 - 8 INCH --------------22
C          = 3 - 81MM MORTAR ----------23
C          = 4 - 4.2 INCH MORTAR-------24
C          = 5 - 120MM MORTAR ---------25
C          = 6 - 122MM HOWITZER -------26
C          = 7   152MM G/H ------------27
C          = 8   122 MRL --------------28
C          = 9   130MM GUN ------------29
C          = 10  T72-125MM ------------30
C          = 11  SAGGER ---------------31
C          = 12  240MM MRL ------------32
C          = 13  M60A3 W/105MM --------33
C          = 14  TOW ------------------34
C          = 15  175 MM GUN -----------35
C          = 16  CAS MISSION----------36
C
      NC=0
      ICALL = 1
      CALL NRAN31(RAND,Z,NC)
C
C     READ IN SOUND BASE LOCATION
C
 100  FORMAT(2I3,I5)
      ICNT=1
C
C     READ IN ARTILLERY MISSION
C
 200  READ(5) (MISHUN(I),I = 1,8)
      IF(EOF(5))1100,250
 250  CONTINUE
      IF(MISHUN(2) .LT. MASTIM) GO TO 200
      IF(MISHUN(1) .EQ. 0) GO TO 200
      CALL TYPE(MISHUN,ITYPE,IFORCE,IPFS)
      IF(ITYPE .EQ. 0) GO TO 200
      CALL UNIQID
 110  CONTINUE
C
C     IF THIS IS THE FIRST MISSION SKIP COMPARISON
      A=1
      IF(ICNT .EQ. 1) GO TO 300
C
C     COMPARE THIS TIME TO LAST MISSION
```

```
C
      IF(MISHUN(2) .EQ. MASTIM  ) GO TO 300
      GO TO 350
  300 CALL FIRETM(A)
      ICNT=ICNT+1
      DO 310 L=1,8
  310 ARTIL(L) = MISHUN(L)
      GO TO 200
C
C     STORE THIS MISSION
C
  350 DO 355 I = 1,6
  355 ARTIL(I)=MISHUN(I)
      A=2
      CALL FIRETM(A)
      MASTIM = MASTIM+1
       IB = MASTIM/100.
      TM = MASTIM - (IB * 100)
      IF(TM .NE. 59) GO TO   356
      MASTIM = MASTIM + 41
  356 CONTINUE
      GO TO 790
C
C     GET FIRETIMES FOR STORED MISSION
C
  358 DO 360 I = 1,6
  360 MISHUN(I)=ARTIL(I)
      GO TO 110
  790 CONTINUE
      CALL RDROF(MASTIM)
      CALL OUTSUM(MASTIM,ICALL)
      ICALL = ICALL + 1
      CALL PRINT (MASTIM)
      B = MASTIM
      B = B/100.
      IB = B
      TM = MASTIM - (IB * 100)
      IF(TM .NE. 59) GO TO   795
      MASTIM = MASTIM + 40
  795 CONTINUE
      MASTIM = MASTIM+1
      IF(MASTIM .EQ. MAXTIM) GO TO 1100
 1000 GO TO 358
 1100 CONTINUE
      MASTIM = 999
      CALL RDROF(MASTIM)
      CALL OUTSUM(MASTIM,ICALL)
      STOP
      END
```

YMBOLIC REFERENCE MAP (R=2)

```
      SUBROUTINE FIRETM(K)
      IMPLICIT INTEGER (A-Z)
      REAL RNG
C**********************************************************************
C
C     THIS SUBROUTINE COMPUTES AND STORES IN AN ARRAY
C     THE FIRETIMES FOR EACH GUN IN A BATTERY.
C     IF A BATTERY WILL FIRE FOR MORE THAN ONE MINUTE
C     THIS ROUTINE STORES THAT MISSION FOR THE NEXT
C     MINUTE, ALONG WITH THE FIRST FIRING TIME IN
C     THAT MINUTE
C     K= 1 - ARTIL MISSION
C     K = 2 - END OF MINUTE, PROCESS MISSIONS FROM LAST MINUTE
C     FOR STORE(J,K,L)
C     J = 1 -OLD ARTIL MISSION
C     J = 2 - NEW ART MISSION
C
       COMMON /  BLK1/MISHUN(60)
     *        /  BLK4/NMISS
     *        /  BLK6/RNG
     *        /  BLK2/ESNDBS,NSNDBS
     *        /  BLK9/MASTIM
      DIMENSION STORE(2,60,300)
C
C     SET PARAMETERS AND CALL RANGE TO COMPUTE THE
C     RANGE FROM THE ARTILERY AND THE SOUND BASE.
C
C**********************************************************************
C
      X=ESNDBS
      Y=NSNDBS
      A=MISHUN(6)
      B=MISHUN(7)
      CALL RANGE(X,Y,A,B)
      IF(K.EQ.2.) GO TO 250
C
C     CALL BATTFIRE TO GET FIRING TIME FOR EACH
C     GUN IN A BATTERY.SET NMISS=1 FOR NEW MISSION
C
      JJ = MISHUN(1)
      IF(MISHUN(3).EQ.0) JJ = 1
      DO 200 J= 1,JJ
      NMISS=1
      CALL BATTFR
      MISHUN(9+J)= MISHUN(9)
 200  CONTINUE
C
C     IF MISSION WILL LAST MORE THAN 1 MINUTE
C     STORE IT AND  INCREMENT   COUNTER TO TELL
C     YOU HOW MANY MISSIONS HAVE BEEN STORED
C
      IF(MISHUN(5) .EQ. 1) GO TO 230
      MISHUN(5) = MISHUN(5)- 1
      NCNT=NCNT+1
      DO 225 J = 1,60
      L = 2
```

```
 225   STORE(L,J,NCNT) = MISHUN(J)
 230   CONTINUE
       RETURN
 250   DCNT = ARTIL
       IF(DCNT .EQ. 0) GO TO 425
C
C      RECALL MISSIONS WHICH BEGAN FIRING IN THE
C      LAST MIN AND LASTED LONGER THAN 1 MINUTE
C
       K = 1
       DO 420 M=1,DCNT
        DO 310 I = 1,60
       MISHUN(I) = STORE(K,I,M)
  310  STORE(K,I,M) = 0
       IF (MISHUN(1) .EQ. 0 ) GO TO 425
C
C      COMPUTE RANGE AND CALL BATTFIRE FOR FIRE TIMES
C
       A=MISHUN(6)
       B=MISHUN(7)
       CALL RANGE (X,Y,A,B)
       JJ = MISHUN(1)
       IF(MISHUN(3).EQ. 0) JJ = 1
       DO 320 J=1,JJ
C
C      SET NMISS=2 FOR A MISSION WHICH IS CONTINUED
C      FROM LAST MIN
C
       NMISS=2
       MISHUN(9)= MISHUN(9+J)
       CALL BATTFR
       MISHUN (9+J) = MISHUN(9)
 320   CONTINUE
C
C      IF MISSION WILL LAST MORE THAN 1 MINUTE
C      STORE IT AND KEEP COUNT HOW MANY YOU HAVE STORED
C
       IF (MISHUN(5) .EQ. 1) GO TO 410
       MISHUN(5) = MISHUN(5)-1
       NCNT=NCNT + 1
        L = 2
       DO 400 J=1,60
 400   STORE(L,J,NCNT) = MISHUN(J)
 410   CONTINUE
 420   CONTINUE
 425   CONTINUE
       IF( NCNT .EQ. 0) GO TO 460
        L = 2
       DO 450 I= 1,NCNT
       DO 450 J= 1,60
        STORE(1,J,I) = STORE(2,J,I)
        STORE(2,J,I) = 0
 450   CONTINUE
 460   CONTINUE
       ARTIL = NCNT
       NCNT=0
       RETURN
```

```
      SUBROUTINE BATTFR
C
C*****************************************************************************
C
C     THIS SUBROUTINE COMPUTES THE FIRING TIMES FOR
C     EACH GUN OR TANK,IT CALLS RATE TO COMPUTE
C     RATE OF FIRE, IT CALLS IMPACT FOR IMPACT TIMES,
C     AND IT CALLS ARRAY TO STORE THE SOUND EVENTS.
C     NMISS = 1 MEANS THIS IS A NEW MISSION
C     NMISS = 2 MEANS THIS MISSION IS CONTINUED FROM
C              A PREVIOUS MINUTE
C
C*****************************************************************************
C
      INTEGER TYP,TIMLFT,FT,FTT,TIMEO
       COMMON /  BLK1/MISHUN(60)
     *         /  BLK4/NMISS
     *         /  BLK5/TYP,IAMP
     *         /  BLK6/RNG
C
C      PICM = FRACTION OF ICM
C
      DATA PICM/.333/
      CALL TYPE(MISHUN,ITYPE,IFORCE,IRES)
      IF(NMISS .EQ.1) GO TO 500
C
C     GET LAST FIRING TIME FOR THIS GUN
C
      ICNT = 0
      FT = MISHUN(9)
      MAXTIM = 60
      GO TO 600
 500  CALL RATE(ROF)
      TIMEO =.1*ROF
      FT = TIMEO
      IF(ITYPE .EQ. 8) TIMEO = 1
      IF(ITYPE .EQ. 12) TIMEO = 1
      MAXTIM = 60
      GO TO 600
C
C     GET RATE OF FIRE FOR THIS GUN
C
 550  CALL RATE(ROF)
      IF(ITYPE .EQ. 12) GO TO 560
      IF(ITYPE .NE. 8) GO TO 590
 560  CONTINUE
      ICNT = ICNT + 1
      IF(ICNT .EQ. 17 .AND. ITYPE .EQ. 12) GO TO 570
      IF(ICNT .NE. 41) GO TO 590
 570  CONTINUE
      FT = 60
      TIMLFT = 0
      GO TO 800
 590  FT = TIMEO + ROF
 600  TIMLFT = MAXTIM - FT
      IF(TIMLFT .LE. 0) GO TO 800
C
```

```
C       CALCULATE THE TIME FOR THE SOUND TO
C       REACH THE SOUND BASE
C
        IRNG=(RNG/.338)
        FTT = FT+ IRNG
        TYP = ITYPE
        IF(FTT .EQ. 0) FTT = 1
        KEY=1
C
C       COMPUTE WHAT BAND OF AMPLITUDE THIS
C       SOUND EVENT IS IN
C
        MISH = ITYPE
        CALL AMPL(MISH,RNG,IAMP)
        CONTINUE
C
C       STORE THIS SOUND EVENT IN MASTER ARRAY
C
        CALL ARRAY(FTT,TYP,IAMP)
        CONTINUE
C
C       CALL IMPACT TO DETERMINE IMPACT TIMES
C
        CALL  TGTARY(FTT)
        IF(RANF(Z) .GT. PICM .AND.
       *  ITYPE .LE. 2) GO TO 750
        IF(ITYPE .EQ. 3) GO TO 750
        IF(ITYPE .EQ. 10) GO TO 750
        IF(ITYPE .EQ. 11) GO TO 750
        IF(ITYPE .EQ. 13) GO TO 750
        IF(ITYPE .EQ. 14) GO TO 750
        IF(ITYPE .EQ. 16) GO TO 750
        CALL IMPACT(MISHUN,FT)
  750   CONTINUE
        TIMEO = 60-TIMLFT
        GO TO 550
  800   MISHUN(9)=FT-60
        RETURN
        END
```

```
      SUBROUTINE ARRAY(SEC,TYP,IAMP)
      IMPLICIT INTEGER (A-Z)
      COMMON /BLKB/SOUND(240,40,11)
      LEVEL 2,SOUND
C     THIS SUBROUTINE STORES SOUND EVENTS IN A
C     3 DIMENSIONAL ARRAY ACCORDING TO THE FOLLOWING
C     ARRAY(SEC,TYP,AMP)
C
      INTEGER SEC,TYP
C      SEC = TIME OF SOUND EVENT (1-240)
C       TYP = TYPE OF WEAPON OR IMPACT (1-18)
C      AMP = RANGE OF AMPLITUDE (1-11)
C
C       MUZZLE                         IMPACT
C        EVENT                          EVENT
C
C     TYP = 1 - 155MM HOWITZER--------21
C         = 2 - 8 INCH ---------------22
C         = 3 - 81MM MORTAR ----------23
C         = 4 - 4.2 INCH MORTAR-------24
C         = 5 - 120MM MORTAR ---------25
C         = 6 - 122MM HOWITZER -------26
C         = 7   152MM G/H ------------27
C         = 8   122 MRL --------------28
C         = 9   130MM GUN ------------29
C         = 10  T72-125MM ------------30
C         = 11  SAGGER ---------------31
C         = 12  240MM MRL ------------32
C         = 13  M60A3 W/105MM --------33
C         = 14  TOW ------------------34
C         = 15  175 MM GUN -----------35
C         = 16  CAS MISSION---------36
C
C
      SEC = SEC + 1
      SOUND(SEC,TYP,IAMP)= SOUND(SEC,TYP,IAMP) +1
      RETURN
      END
```

```
      SUBROUTINE IMPACT(MISHUN,FT)
      IMPLICIT INTEGER (A-Z)
      REAL RNG
C
C     THIS SUBROUTINE COMPUTES THE TIME THE IMPACT
C     SOUND WILL REACH THE SOUND BASE.
C
      DIMENSION MISHUN(60)
      COMMON/BLK2/ESNDBS,NSNDBS/
     1BLK4/NMISS/BLK5/TYP,IAMP/BLK6/RNG
C
C     GET RANGE FROM GUN TO TARGET
C
      X=MISHUN(6)
      Y=MISHUN(7)
      A=MISHUN(3)
      B=MISHUN(4)
      CALL RANGE(X,Y,A,B)
      IF(MISHUN(3) .EQ. 0) RNG = .5
C
C     COMPUTE FLIGHT TIMES
C
      FLGHT = 4. * RNG
C
C     COMPUTE TARGET RANGE FROM THE SOUND BASE
C
      IF(MISHUN(3) .NE. 0) GO TO 100
       A = MISHUN(6)
       B = MISHUN(7)
 100   CONTINUE
      X = ESNDBS
      Y = NSNDBS
      CALL RANGE(X,Y,A,B)
      SBRNG = RNG/.336
C
C     SET KEY FOR COMPUTING AMPLITUDE OF IMPACT
C     FROM THIS GUN
C
      KEY = 2
      CALL TYPE(MISHUN,ITYPE,IFORCE,IRES)
      TYP = ITYPE + 20
      CALL AMPL(TYP,RNG,IAMP)
      SE = SBRNG + FLGT + FT
      IF (SE .GE. 240) SE = 240
C
C     STORE THIS SOUND EVENT IN THE MASTER ARRAY
C
      CALL ARRAY(SE,TYP,IAMP)
 600  CONTINUE
      RETURN
      END
```

```
      SUBROUTINE RANGE(X,Y,A,B)
      INTEGER A,B,X,Y
      COMMON/BLK6/RNG
C
C     THIS SUBROUTINE CALCULATES THE RANGE BETWEEN
C     THE TWO COORDINATES GIVEN BY XY AND AB
C
      C=((X-A)**2+(Y-B)**2)
      RNG = SQRT(C)/10.
      RETURN
      END
```

```
      SUBROUTINE RATE(ROF)
C
C     THIS SUBROUTINE COMPUTES A RATE OF FIRE
C     FOR INDIVIDUAL SHOTS. THE SUSTAINED RATES
C     OF FIRE ARE IN ARRAY RAOF
C
      COMMON/BLK1/MISHUN(60)/BLK7/NC
      COMMON /BLK9/MASTIM
C
C     RAOF(I)  I=1--155MM
C               =2--8INCH
C               =3--81MMMORTAR
C               =4--4.2 INCH MORTAR
C               =5--120MM
C               =6--122MM
C               =7--152MM G/H
C               =8--MRL
C               =9--130MM GUN
C               =10-T72-125MM
C               =11-SAGGER
C               =12-240 MRL
C               =13-M60A3 W/105MM
C               =14-TOW
C               =15-175 MM GUN
C               =16-CAS MISSION
C
      DIMENSION RAOF(20)
       DIMENSION NBOM(2,10)
      DATA RAOF/ 1.0,  .5,  8.,  3.,  3.,  1.,  1., 40.,  1., 0.0,
     *            0.0, 16.,  0., 0.0, 0.5,  0.,0.0,0.0,0.5,0.0/
      DATA (NBOM(1,J),J=1,10)/
     *      8,   8,   1,   0,   0,   0,   0,   0,   0,   0/
       DATA (NBOM(2,J),J=1,10)/
     *      8,   8,   2,   0,   0,   0,   0,   0,   0,   0/
      CALL TYPE(MISHUN,ITYPE,IFORCE,IRES)
      I = ITYPE
      IF(MISHUN(3).EQ. 0) GO TO 200
         IF(MISHUN(6) .EQ. 0) GO TO 300
      IF(RAOF(I) .NE. 0.0) GO TO 100
      ROF = 0.0
      RETURN
 100  CONTINUE
      RTE=(1./RAOF(I))*60.
      SIGMA=.1*RTE
      CALL NRAN31(RAND,Z,NQ)
      ROF=RTE + RAND * SIGMA
      MIN =.33 * RTE
      IF(ROF .LE. MIN) ROF = MIN
      IF(I . EQ. 8) ROF = 1.5
      RETURN
 200  CONTINUE
      RTE = MISHUN(1)
      RTE = RTE/100. + .5
      ROF = (1./RTE) * 60.
      RETURN
 300     CONTINUE
C
```

```
C       THIS IS A CAS MISSION THE RATE WILL BE THE NUMBER
C        OF BOMBS DROPPED
C
        LDS = MISHUN(1) - ((MISHUN(1)/100)*100)
          NTYPE = MISHUN(1)/100
          RTE = NBOM(IFORCE,NTYPE) * LDS
        IF(IFORCE .EQ. 1 .AND. NTYPE.  .EQ. 3)  RTE = RTE/30.
         ROF = (1./RTE) * 60.
        IF(NTYPE .EQ. 3 .AND.
     *    IFORCE .EQ. 1 .AND.
     *    MISHUN(5) .EQ. 1 .AND.
     *    MASTIM .EQ. MISHUN(2)) MISHUN(5) = 30
         RETURN
        END
```

```
      SUBROUTINE AMPL (MISH,RNG,IAMP)
C***********************************************************************
C
C     IN THIS SUBROUTINE THE AMPLITUDE OF EACH SOUND
C     IS CALCULATED IN DB (REF .0002 UBARS).
C     THE INITIAL AMPLITUDE IS CALCULATED USING EQUIVALENT
C     BARE TNT CHARGES , THESE CHARGES ARE EQUIVALENT
C     COMPUTATIONALY  AT THE ONE THIRD POWER.
C     ARRAY TNT CONTAINS THE EQUIVALENT CHARGES FOR
C     3 DIFFERENT FIRING CHARGES FOR EACH RANGE BEING
C     FIRED.  THE CHARGE USED FOR EACH SHOT IS DETERMINED
C     BY A RANDOM NUMBER DRAW FOR THE THREE AVAILABLE
C     FIRING CHARGES. CHARGES IN BOTH TNT AND HE ARE ALREADY
C     TO THE ONE THIRD POWER
C     IF THIS EVENT IS AN IMPACT THEN THE EQUIVALENT
C     CHARGE IS OBTAINED FROM ARRAY HE
C
C     AFTER CALCULATING THE AMPLITUDE OF THE SOUND EVENT
C     IT IS PLACED IN AN AMPLITUDE BIN AS FOLLOWS.
C
C         AMPL        AMPL
C          IN
C          DB         BIN
C         > 110        1
C         105-110      2
C         100-105      3
C          95-100      4
C          92-95       5
C          89-92       6
C          87-89       7
C          84-87       8
C          80-84       9
C          70-80      10
C          < 70       11
C
C         A= AMPL IN UBARS
C         RNG=  RANGE IN KM
C                                       I= TYPE OF GUN
C         TNT(I,J,K)                       1 = 155MM
C            I = TYPE OF GUN (1-20)        2 = 8 INCH
C            J = RANGE (1-30)              3 = 81MM MORTAR
C            K = FIRING CHARGE (1-3)       4 = 4.2 INCH MORTAR
C                                          5 = 120MM
C         HE(I)                            6 = 122MM
C           I= TYPE OF GUN WHICH           7 = 152MM G/H
C              FIRED THIS ROUND            8 = MRL
C                                          9 = 130MM GUN
C                                         10 = T72 - 125MM
C                                         11 = SAGGER
C                                         12 = 240 MRL
C                                         13 = M60A3 W/105MM
C                                         14 = TOW
C                                         15 = 175MM GUN
C                                         16 = REDEYE
C
C
C***********************************************************************
```

```
C
      DIMENSION TNT(20,30,3),
     *          HE(40)
     *          ,CASBM(2,10)
      COMMON /BLK1/MISHUN(60)
      COMMON /BLK7/NQ
      DATA (TNT(1,K,1),K=1,30)/
     *     1.46,  1.46,  1.59,  1.90,  2.13, 25*2.36/
      DATA (TNT(1,K,2),K=1,30)/
     *     3*1.46,  1.59,  1.90, 7*2.13, 18*2.36/
      DATA (TNT(1,K,3),K=1,30)/
     *     4*1.46,  1.59, 4* 1.90, 3*2.13, 18*2.36/
      DATA (TNT(2,K,1),K=1,30)/
     *     1.63,  1.87, 2.34,  2.50,  2.81,  2.81,  24*3.04/
      DATA (TNT(2,K,2),K=1,30)/
     *     1.63,  1.63,  2.34,  2.34,  2.50,  2.50, 8*2.81,16*3.04/
      DATA (TNT(2,K,3),K=1,30)/
     *     1.63,  1.63,  1.87,  1.87, 2*2.34,  5*2.50, 3*2.81, 16*3.04/
      DATA (TNT(3,K,1),K=1,30)/
     *     .555,  29*.617/
      DATA (TNT(3,K,2),K=1,30)/
     *     .524, 3*.555, 26*.617/
      DATA (TNT(3,K,3),K=1,30)/
     *     .524, 3*.555, 26*.617/
      DATA (TNT(4,K,1),K=1,30)/
     *     .745,  .763,  .763,  .839,     26*.927/
      DATA (TNT(4,K,2),K=1,30)/
     *     .745, .745,  .763,  .839,  .921, 25*.927/
      DATA (TNT(4,K,3),K=1,30)/
     *     3*.745,  .839, .921, 25*.927/
      DATA (TNT(5,K,1),K=1,30)/
     *     .355,.427,.479,.530, 26*.618/
      DATA (TNT(5,K,2),K=1,30)/
     *     .427,.479,.530,.575, 26*.618/
      DATA (TNT(5,K,3),K=1,30)/
     *     .479,.530,.575, 27*.618/
      DATA (TNT(6,K,1),K=1,30)/
     *     2*.538,1.37,1.67,2.02,2*2.34,23*2.82/
      DATA (TNT(6,K,2),K=1,30)/
     *     3*.538,1.37,1.67,2*2.02,5*2.34, 18*2.82/
      DATA (TNT(6,K,3),K=1,30)/
     *     4*.538,1.37, 2*1.67, 4*2.02, 2.34, 18*2.82/
      DATA (TNT(7,K,1),K=1,30)/
     *     2*1.48, 1.68, 1.90, 2.28, 2.50, 2.56, 23*2.63/
      DATA (TNT(7,K,2),K=1,30)/
     *     3*1.48, 1.68, 1.90, 2.28, 2.50,      8*2.56,15*2.63/
      DATA (TNT(7,K,3),K=1,30)/
     *     4*1.48, 1.68, 1.90, 2.28, 8*2.50, 2.56, 14*2.63/
      DATA (TNT(8,K,1),K=1,30)/
     *     30*1.37/
      DATA (TNT(8,K,2),K=1,30)/
     *     30*1.37/
      DATA (TNT(8,K,3),K=1,30)/
     *     30*1.37/
      DATA (TNT(9,K,1),K=1,30)/
     *     7*.298, 6*2.75,17*3.08/
      DATA (TNT(9,K,2),K=1,30)/
```

```
*       7*.298, 2*.353, 4*.415, 9*2.75, 8*3.08/
 DATA  (TNT(9,K,3),K=1,30)/
*       9*.298, 4*.353, 6*.415, 3*2.75, 8*3.08/
 DATA  (TNT(10,K,1),K=1,30)/
*       30*2.50/
 DATA  (TNT(10,K,2),K=1,30)/
*       30*2.50/
 DATA  (TNT(10,K,3),K=1,30)/
*       30*2.50/
 DATA  (TNT(11,K,1),K=1,30)/
1        30*1.825/
 DATA  (TNT(11,K,2),K=1,30)/
1        30*1.825/
 DATA  (TNT(11,K,3),K=1,30)/
1        30*1.825/
 DATA  (TNT(12,K,1),K=1,30)/
*       30*1.56/
 DATA  (TNT(12,K,2),K=1,30)/
*       30*1.56/
 DATA  (TNT(12,K,3),K=1,30)/
*       30*1.56/
 DATA  (TNT(13,K,1),K=1,30)/
*       30*2.29/
 DATA  (TNT(13,K,2),K=1,30)/
*       30*2.29/
 DATA  (TNT(13,K,3),K=1,30)/
*       30*2.29/
 DATA  (TNT(14,K,1),K=1,30)/
1       30*1.825/
 DATA  (TNT(14,K,2),K=1,30)/
1       30*1.825/
 DATA  (TNT(14,K,3),K=1,30)/
1       30*1.825/
 DATA  (TNT(15,K,1),K=1,30)/
*       12*2.90, 6*3.43, 12*3.95/
 DATA  (TNT(15,K,2),K=1,30)/
*       18*3.43, 12*3.95/
 DATA  (TNT(15,K,3),K=1,30)/
*       30*3.95/
 DATA  (HE(I),I=1,20)/
*       2.605,    3.311,   1.341,   1.983,   1.726,
*       2.089,    1.934,   2.089,   2.089,   0.0,
*       0.0,      2.089,   0.0,     0.0,     3.288,
*       0.0,      0.0,     0.0,     0.0,     0.0/
 DATA  (CASBM(1,J),J=1,10)/
*       4.54,4.10,3.50, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0/
 DATA  (CASBM(2,J),J=1,10)/
*       4.54,4.10,5.76, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0/
 IF(MISH .GT.20) GO TO 500
C
C       SELECT THE CHARGE TO BE USED FOR THIS SHOT
C
        B = RANF(Z)
        K = 2
        IF( B .LE. .33) K =1
        IF( B .GE. .67) K =3
        J = RNG + .5
```

```
      IF ( J .LE. 1) J = 1
      IF ( J .GE. 30) J = 30
      I = MISH
      BANG = TNT(I,J,K)
      GO TO 600
C
C     IF THIS IS AN IMPACT EVENT GET THE EXPLOSIVE
C     CHARGE WEIGHT.
C
 500    INDEX = MISH -20
      CALL TYPE(MISHUN,ITYPE,IFORCE,IRES)
           IF(ITYPE .NE. 16) GO TO 550
           IORD = MISHUN(5)/100
       BANG = CASBM(IFORCE,IORD)
        GO TO 600
 550  CONTINUE
       BANG = HE(INDEX)
 600  CONTINUE
C
C     CALCULATE THE AMPLITUDE OF THE SOUND IN PSI
C
      R = RNG * 3280.84
      IF(R .NE. 0.) GO TO 700
      WRITE(6,900) MISH,RNG,IAMP
 900  FORMAT(1X,I4,F10.4,I4,//)
 700  CONTINUE
      PSI = 210. *((BANG/R)**1.407)
C
C     NOW CONVERT TO UBARS AND THEN TO DB
C
      PUBAR = PSI * 1000000. / 14.5
C
      DB = 20. * ALOG10(PUBAR /.0002)
      DB = DB- 10
      CALL NRAN31(RAND,Z,NO)
      DB = DB +( 8.0 * RAND)
C     SELECT THE RANGE BIN FOR THIS AMPLITUDE
      IDB = DB
      IF(ITYPE .GE. 5 .OR.
     * ITYPE.LE.9) CALL AVG(IDB,ICALL)
      IF (DB .GE. 110.) IAMP = 1
      IF (DB .LT. 110.) IAMP = 2
      IF (DB .LT. 105.) IAMP = 3
      IF (DB .LT. 100.) IAMP = 4
      IF (DB .LT. 95.)  IAMP = 5
      IF (DB .LT. 92.)  IAMP = 6
      IF (DB .LT. 89.)  IAMP = 7
      IF (DB .LT. 87.)  IAMP = 8
      IF (DB .LT. 84.)  IAMP = 9
      IF (DB .LT. 80.)  IAMP = 10
      IF (DB .LT. 70.)  IAMP = 11
      RETURN
      END
```

```
      SUBROUTINE AVG(IAMP,ICALL)
      IF(ICALL .EQ. 999)  GO TO 500
      ITOT = ITOT + IAMP
      ICNT = ICNT + 1
      RETURN
500   CONTINUE
      IAVG = ITOT/ICNT
      WRITE(6,900) IAVG
900   FORMAT(1H1,//////////20X,I12,1H1)
      RETURN
      END
```

```
      SUBROUTINE PRINT(MASTIM)
C
C*********************************************************************
C
C     SOUND(SEC,TYP,AMP)
C
C      SEC = TIME OF SOUND EVENT (1-240)
C      TYP = TYPE OF WEAPON OR IMPACT (1-40)
C      AMP = RANGE OF AMPLITUDE (1-11)
C
C       MUZZLE                          IMPACT
C        EVENT                           EVENT
C
C     TYP = 1 - 155MM HOWITZER--------21
C         = 2 - 8 INCH ---------------22
C         = 3 - 81MM MORTAR ----------23
C         = 4 - 4.2 INCH MORTAR-------24
C         = 5 - 120MM MORTAR ---------25
C         = 6 - 122MM HOWITZER -------26
C         = 7   152MM G/H ------------27
C         = 8   122 MRL --------------28
C         = 9   130MM GUN ------------29
C         = 10  T72-125MM ------------30
C         = 11  SAGGER ---------------31
C         = 12  240MM MRL ------------32
C         = 13  M60A3 W/105MM --------33
C         = 14  TOW ------------------34
C         = 15  175 MM GUN -----------35
C         = 16  CAS MISSION---------36
C
C
C*********************************************************************
C
      IMPLICIT INTEGER (A-Z)
      COMMON/BLK8/SOUND(240,40,11)
      COMMON / BLK11/IDARAY(240,300)
      LEVEL 2,IDARAY
      LEVEL 2,SOUND
      DIMENSION BLANK(100)
      INTEGER AMP(2,12)
      DATA BLANK/'  ',' 1',' 2',' 3',' 4',' 5',' 6',' 7',' 8',' 9','10',
     1'11','12','13','14','15','16','17','18','19','20',
     *'21','22','23','24','25','26','27','28','29','30',
     *'31','32','33','34','35','36','37','38','39','40',
     *'41','42','43','44','45','46','47','48','49','50',
     *'51','52','53','54','55','56','57','58','59','60',
     *'61','62','63','64','65','66','67','68','69','70',
     *'71','72','73','74','75','76','77','78','79','80',
     *'81','82','83','84','85','86','87','88','89','90',
     *'91','92','93','94','95','96','97','98','99'/
C
C     THIS SUBROUTINE WILL PRINT OUT THE SOUND
C     EVENTS AND UPDATE THE ARRAY
C
      AMP(12)=0
      WRITE(6,910) MASTIM
   75 CONTINUE
```

```
      DO 200 N=1,60
      DO 400 J=1,11
      DO 400 K = 1,40
      AMP(1,J) = AMP(1,J) + SOUND(N,K,J)
      IF( K . LT. 5) GO TO 390
      IF( K .GT. 9 ) GO TO 390
      AMP(2,J) = AMP(2,J) + SOUND(N,K,J)
  390 CONTINUE
  400 CONTINUE
      DO 500 J=1,10
  500 AMP(1,12) = AMP(1,12) + AMP(1,J)
      WRITE(6,900) N,BLANK(AMP(1,12)+1),((BLANK(AMP(I,J)+1),I=1,2),
     *J=1,11)
  502 CONTINUE
C
C     ZERO FILL ARRAY AMP
C
      DO 510 M = 1,2
      DO 510 J = 1,12
  510 AMP(M,J) = 0
  200 CONTINUE
  900 FORMAT(2X,I2,8X,A2,7X,11(A2,'/',A2,3X))
C
C     MOVE ALL THE SOUND EVENTS DOWN ONE MINUTE IN ARRAY SOUND
C
      DO 1000 N = 1,180
      DO 1000 K = 1,40
      DO 1000 J=1,11
      NN= N+60
      SOUND(N,K,J) = SOUND(NN,K,J)
 1000 CONTINUE
       DO 1500 N = 181,240
      DO 1500 K = 1,40
       DO 1500 J = 1,11
      SOUND(N,K,J) = 0
 1500 CONTINUE
      DO 2000 N = 1,180
      NN = N + 60
      DO 2000 K = 1,300
       IDARAY(N,K) = IDARAY(NN,K)
 2000 CONTINUE
       DO 3000 I = 61,240
      DO 3000 J = 1,300
       IDARAY(I,J) = 0
 3000 CONTINUE
      RETURN
  910 FORMAT(1H1,8X,'MIN = ',I5,
     *20X,'A M P L I T U D E    I N    D B ',/
     *1X,'SEC',8X,'TOT', 6X,'> 110  105-110 100-105  95-100  92-95   89
     *92   87-89   84-87   80-84   70-80    < 70',/)
       END
```

AD-A112 366 ARMY MATERIEL SYSTEMS ANALYSIS ACTIVITY ABERDEEN PROV--ETC F/G 17/1
SOUND RANGING EFFECTIVENESS MODEL (SREM).(U)
DEC 81 W J HUGHES, H C DUBIN
UNCLASSIFIED AMSAA-TR-333 NL

2 of 2

END
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4-82
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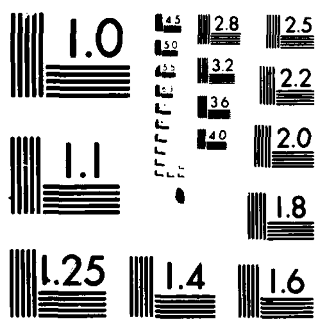

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
      SUBROUTINE  RDRCF (MASTIM)
      IMPLICIT INTEGER (A-Z)
      REAL ROF,CUMROF(100),NUMRED(100)
      COMMON /BLK8/SOUND(240,40,11)
      LEVEL 2,SOUND
C
C***********************************************************************
C
C      THIS SUBROUTINE EXTRACTS FROM ARRAY SOUND THE
C      CUMULATIVE RATE OF FIRE ( THE INDEX FOR CUMROF(I)).
C      IT THEN STORES IN THAT LOCATION THE RED RATE OF FIRE.
C
C      TOT = CUMULATIVE RATE OF FIRE + IMPACTS
C      RED = CUMULATIVE RATE OF RED MUZZLE EVENTS
C***********************************************************************
C
      IF (MASTIM .EQ. 999) GO TO 700
      TOT=0
      DO 500 N=1,60
      DO 400 J=1,11
      DO 400 K = 1,40
      TOT=TOT+SOUND(N,K,J)
      IF(K .GT. 9) GO TO 300
      IF(K .LT. 5) GO TO 300
      RED=RED+SOUND(N,K,J)
  300 CONTINUE
  400 CONTINUE
      IF(TOT .GE. 99) TOT = 99
      CUMROF(TOT+1) = CUMROF(TOT+1) + RED
      NUMRED(TOT+1) = NUMRED(TOT+1)+1
      RED = 0
      TOT = 0
  500 CONTINUE
      RETURN
 700  CONTINUE
      WRITE(6,900)
      DO 800 I = 1,100
      IF(NUMRED(I) .NE. 0.) GO TO 750
      ROF = 0.
      GO TO 760
  750  CONTINUE
      ROF = CUMROF(I)/NUMRED(I)
  760  CONTINUE
      II =I-1
      WRITE (6,910) II,ROF
 800  CONTINUE
 900  FORMAT(1H1,10X,'TOT',7X,'RED',/9X'EVENTS   MUZZLES'//)
 910  FORMAT (10X,I2,7X,F6.2)
      RETURN
      END
```

```
      SUBROUTINE  EVENTS (ROF5,MASTIM, ICALL,ROF)
      IMPLICIT INTEGER (A-Z)
      REAL PRCNT
      COMMON /BLK8/SOUND(240,40,11)
      LEVEL 2,SOUND
      DIMENSION SEC(300)
C      SEC(I) I = 1-100
C     STORED IS THE NUMBER OF SECS DURING WHICH
C     THE EVENTS PER SECOND = I
      IF(MASTIM .EQ. 999) GO TO 700
      ICNT = ICNT + 1
       TOT = (ROF5 * .2) / ROF
       SEC(TOT+1) = SEC(TOT + 1) + 1
      RETURN
  700 CONTINUE
      WRITE(6,905)
 905  FORMAT(1H1)
      WRITE(6,910)
      ICALL = ICALL - 10
      DO 800 I = 1,100
      PRCNT = (SEC(I)*100.)/(ICNT * 1.0)
       II = I*ROF
       JJ = (I*ROF)-ROF
       WRITE (6,900) JJ,II,PRCNT
  800 CONTINUE
  900 FORMAT (16X,I6,'-',I6,10X,F6.4/)
 910  FORMAT (40X,'PRCNT',/21X,'ROF',18X,'OF',/40X,'GAME',//)
      RETURN
      END
```

```
      SUBROUTINE OUTSUM(MASTIM,ICALL)
C
       IMPLICIT INTEGER (A-Z)
C
       COMMON /  BLK8/SOUND(240,40,11)
      COMMON /BLK12/CT,SYS,ROF
       LEVEL 2,SOUND
C
       REAL PRCNT
     *     ,ROF1
     *     ,LINTOT
     *     ,FACTOR
     *     ,JACK(80)
     *     ,ROF3(80)
     *     ,OUTSM2(20)
     *     ,OUTSM1(80,20)
C
       DIMENSION  ALPH(20)
     *            ,FMT1(5)
     *            ,FMT2(7)
     *            ,SUM1(6)
     *            ,ROF5F(300)
     *            ,RUNTOT(500)
     *            ,ROM5(300)
     *            ,DIST(6,3,11)
C
       DATA   FMT1 /'1X,I4,'
     *              ,'1H-,I4,'
     *              ,'        '
     *              ,'F6.2,   '
     *              ,'F8.2)   '
     *              /
C
       DATA   FMT2 /'2X,4HTROF'
     *              ,',8X,      '
     *              ,'          '
     *              ,'A6,4HLCST,'
     *              ,'2X,       '
     *              ,'3HTOT     '
     *              ,'//)       '
     *              /
C
       DATA   DASH /'6H   ---,'/
C
       DATA  BLANK /'          '/
C
       DATA   NMBR /'F6.2,     '/
C
       DATA  NMBR2 /'F8.2,     '/
C
       DATA   ALPH /'1','2','3','4','5',
     *               '6','7','8','9','10',
     *               '11','12','13','14','15',
     *               '16','17','18','19','20'
     *              /
C
       DATA  ALPH1 /'0'/
```

```
C
C***********************************************************************
C
C      THIS SUBROUTINE CALCULATES THE RATE OF FIRE OVER A FIVE MINUTE
C      PERIOD (ROF5) AND THEN CONSIDERS ALL SOUND EVENTS IN THE
C      NEXT SIX SECOND PERIOD
C        CT = CRITICAL THRESHOLD
C           THIS IS THE NUMBER OF EVENTS THAT MAY OCCUR IN A SIX SECOND
C           WINDOW AND STILL BE DISTINGUISHABLE
C
C       SUM1(I) I=1,6 = NO. OF MUZZLE EVENTS PER SEC(I)
C                       IN THE SIX SECOND WINDOW
C       ROM5(I) I=1,300 TOTAL MUZZLE EVENTS IN SEC I OF 5 MIN WINDOW
C
C       ROF5F(I) I=1,300  TOTAL NO. OF SOUND EVENTS IN SECOND I OF
C                         THE 5 MIN WINDOW
C       ROF5 =  TOTAL NO. OF SOUND EVENTS IN 5 MIN WINDOW
C
C       ROM  =  TOTAL NO. OF MUZZLE EVENTS IN 5 MIN WINDOW
C
C       IROF = COUNTER FOR SECOND OF 5 MIN WINDOW
C
C       IDIST = COUNTER FOR SECOND OF 6 SEC WINDOW
C
C       THRESH = TOTAL NO. OF SOUND EVENTS IN 6 SEC WINDOW
C
C       REDSUM = TOTAL RED MUZZLES IN 6 SEC WINDOW
C
C       MUZSUM = TOTAL MUZZLE EVENTS IN 6 SEC WINDOW
C       ROFBIN = RATE OF FIRE BIN BASED ON
C                    1 RATE OF FIRE FOR 5 MIN
C                    2 RATE OF FIRE FOR 6 SEC
C
C       ROF3(I) = NO. OF TIMES RATE OF FIRE = (I * ROF)
C
C       RDNTOT(I) I =1,500  TOT NO. OF DETECTABLE RED MUZZLE EVENTS
C       FOR MIN I OF GAME
C
C      REDSUM = NUMBER OF RED MUZZLE EVENTS
C       OUTSM1(I,J,K)
C              I = 1,80 RATE OF FIRE BINS IN INCREMENTS OF ROF
C                  ROF = INCREMENTS FOR I
C              J = NUMBER OF RED MUZZLE EVENTS
C
C      STORED IS THE NUMBER OF TIMES CONDITIONS I,J ARE MET.
C
C      DIST(I,J,K)  THIS IS THE SIX SECOND WINDOW UNDER CONSIDERATION
C              I = 1,6 SECOND
C              J = 1,2  1 = ALL SOUND EVENTS
C                       2 = RED MUZZLE EVENTS
C              K = 1,11  AMPLITUDE BINS
C
C***********************************************************************
C
C       THE FOLLOWING ARE INPUTS FOR THIS SUBROUTINE
C       ROF = INCREMENT FOR OUTSM1
C
```

```
C       CT = CRITICAL THRESHOLD (MAX = 18)
C      ISYS = TYPE OF SYSTEM REPORTING
C             1 - AUTOMATED
C             2 - MANUAL
C
C
C*********************************************************************
C
C
C       IF THIS IS THE END OF INPUT GO TO PRINTOUT
C
      IF(MASTIM .EQ. 999) GO TO 500
         IF(ICALL .GT. 5) GO TO 190
C
C      UP TO STATEMENT 190 IS ONLY TO INITIATE THE FIRST FIVE MINUTES
C      DURING WHICH WE WILL CONSIDER THE RATE OF FIRE
C*********************************************************************
C
   50  CONTINUE
         ICNT = ICNT + 1
         DO 120 I = 1,60
           DO 110 J = 1,40
             DO 100 K = 1,11
               II = 60 *(ICALL-1)+ I
               ROF5F(II) = ROF5F(II) + SOUND(I,J,K)
                 IF(J .GE. 21) GO TO 90
                   ROM5(II) = ROM5(II) + SOUND(I,J,K)
   90            CONTINUE
  100        CONTINUE
  110      CONTINUE
  120    CONTINUE
         IF(ICALL .NE. 5) GO TO 180
           DO 160 I = 1,6
             DO 150 K =1,11
               DO 140 J = 1,40
                 DIST(I,1,K) = DIST(I,1,K) + SOUND((54+I),J,K)
                         IF(J .LT. 5 .OR.
     *                   J .GT. 9 .AND.
     *                   J .NE. 12) GO TO 130
                   DIST(I,2,K) = DIST(I,2,K) + SOUND((54+I),J,K)
  130            CONTINUE
  140          CONTINUE
  150        CONTINUE
  160      CONTINUE
C
           IROF = 1
           IDIST = 1
           ROF5  = 0
           ROM = 0
           DO 170 I = 1,300
             ROM = ROM + ROM5(I)
             ROF5 = ROF5 + ROF5F(I)
  170      CONTINUE
  180    CONTINUE
         RETURN
  190    CONTINUE
C
```

```
C*********************************************************************
C
C         THE 5 MINUTE INITIALIZATION IS OVER CONTINUE.
C
C*********************************************************************
C
C         SUBTRACT THE RATE OF EVENTS FOR THE LAST SECOND
C          FROM ROF5 AND SUBTRACT THE RATE OF FIRE FROM
C          ROM FOR THE LAST SECOND
C
          DO 380 TIM = 1,60
                OLDROF = ROF5/ROF
                ROF5 = ROF5 - ROF5F(IROF)
                TEMROF = 0
                TEMROM = 0
                ROM = ROM - ROM5(IROF)
C
C               REMOVE THE OLDEST SECOND FROM DIST(I,J,K) AND
C               REPLACE IT WITH THE NEXT SECOND FROM SOUND(I,J,K)
C
                DO 210 I = 1,11
                  DO 200  J = 1,3
                    DIST(IDIST,J,I) = 0
  200             CONTINUE
  210           CONTINUE
                SUM1(IDIST) = 0
                DO 270 K = 1,11
                  DO 260 J = 1,40
C
C                   TOTAL EVENTS FOR 1 SEC
                    TEMROF = TEMROF + SOUND(TIM,J,K)
                      IF(J .GE. 21) GO TO 230
C
C                       TOTAL MUZ EVENTS FOR 1 SEC
                        TEMROM = TEMROM + SOUND(TIM,J,K)
  230                 CONTINUE
C
C                   TOTAL EVENTS / SEC / AMP
                    DIST(IDIST,1,K) = DIST(IDIST,1,K) + SOUND(TIM,J,K)
                      IF(J .GE.21) GO TO 250
C
C                           TOT MUZ EVENTS / SEC
                        SUM1(IDIST) = SUM1(IDIST) + SOUND(TIM,J,K)
                          IF(J .LT. 5 .OR.
     *                    J .GT. 9 .AND.
     *                    J .NE. 12) GO TO 240
C
C                           RED MUZ EVENTS / SEC / AMP
                            DIST(IDIST,2,K) = DIST(IDIST,2,K)
     *                      + SOUND(TIM,J,K)
C
C                           RED MUZ EVENTS / SEC / AMP
                            DIST(IDIST,3,K)= DIST(IDIST,3,K)
     *                      + SOUND(TIM,J,K)
  240                     CONTINUE
  250                 CONTINUE
  260             CONTINUE
```

```
  270          CONTINUE
C
C              ROF5 = TOTAL EVENTS OVER 5 MIN PERIOD
C              ROM  = TOTAL MUZZLE EVENTS OVER 5 MIN PERIOD
C
C              ADD THE RATE OF FIRE FOR THE NEWEST SECOND
C
               ROF5 = ROF5 + TEMROF
               ROF5F(IROF) = TEMROF
               ROM = ROM + TEMROM
               ROM5(IROF) = TEMROM
               IROF = IROF + 1
C
C              IF THIS IS THE END OF A 5 MIN PERIOD, SUBROUTINE
C              EVENTS WILL RECIEVE THE PRESENT 5MIN TOTAL EVENTS
C
                 IF(IROF .NE. 300) GO TO 280
                   CALL EVENTS (ROM,MASTIM,ICALL,ROF)
                   IROF = 1
  280            CONTINUE
               NEWROF = ROF5/ROF
C
C              IF THE RATE OF SOUND EVENTS HAS CHANGED CONSIDER
C              ALL TARGETS IN THE SIX SECOND WINDOW
C
                 IF(OLDROF .EQ. NEWROF) GO TO 310
                   DO 300 I =1,11
                     DO 290 J = 1,6
                       DIST(J,3,I) = DIST(J,2,I)
  290                CONTINUE
  300              CONTINUE
  310            CONTINUE
               IDIST = IDIST + 1
                 IF(IDIST .GT. 6) IDIST = 1
               REDSUM = 0
               JAKSM  = 0
               THRESH = 0
C
C              ADD UP ALL SOUND EVENTS IN 6 SEC WINDOW
C
                 DO 330 SEC = 1,6
                   DO 320 AMP = 1,10
                     THRESH = THRESH + DIST(SEC,1,AMP)
  320              CONTINUE
  330            CONTINUE
C
C              IF THE THRESHOLD HAS NOT BEEN EXCEEDED ADD UP ALL
C              THE RED MUZZLE EVENTS IN THAT WINDOW
               REDSUM = CT + 1
                 IF(THRESH .GT. CT) GO TO 360
                   REDSUM = 0
                   DO 350 SEC = 1,6
                     DO 340 AMP = 1,10
                       REDSUM = REDSUM + DIST(SEC,2,AMP)
                       JAKSM = JAKSM + DIST(SEC,3,AMP)
                       DIST(SEC,3,AMP) = 0
  340                CONTINUE
```

```
  350                CONTINUE
                    NTOT = NTOT + REDSUM
C
C                   CALL OTSUM2 TO SEE IF ANY OF THESE TARGETS
C                   ARE UNIQUE
C
                    CALL OTSUM2(TIM,ICNT)
  360             CONTINUE
C
C               CALCULATE THE RATE OF FIRE BIN THAT THESE EVENTS
C               GO TO
C               ROFBN1 WILL CONTAIN THE RATE OF MUZZLE EVENTS
C                      AVERAGED OVER THE 5 MIN WINDOW
C               ROFBN2 WILL CONTAIN THE RATE OF MUZZLE EVENTS
C                      IN THE 6 SECOND WINDOW EXTRAPOLATED
C                      TO 1 MIN
C
C
          ROFBN1 = ((ROM/5)/ROF) + 1
                MUZSUM = 0
                  DO 370 M1 = 1,6
                    MUZSUM = MUZSUM + SUM1(M1)
  370             CONTINUE
                ROFBN2 =(MUZSUM * 10 / ROF) + 1
C
                IF(SYS .EQ. 1) ROFBIN = ROFBN1
                IF(SYS .EQ. 2) ROFBIN = ROFBN2
C
                IF(ROFBIN .GE. 80) ROFBIN = 60
C
C               STORE IN OUTSM1 HOW OFTEN YOU WERE ABLE TO DETECT
C               THIS MANY RED MUZZLES AT THIS RATE OF FIRE
C
                OUTSM1(ROFBIN,(REDSUM+1)) = OUTSM1(ROFBIN,REDSUM+1) +1
                JACK(ROFBIN) = JACK(ROFBIN) + JAKSM
                ROF3(ROFBIN) = ROF3(ROFBIN) + 1
  380     CONTINUE
          ICNT = ICNT + 1
          CALL OTSUM2(TIM,ICNT)
          RUNTOT(ICNT) = NTOT
          NTOT = 0
          ITOT = 0
        RETURN
C
C*****************************************************************************
C
C         THE END OF THE INPUT HAS BEEN REACHED
C         THIS IS THE BEGINING OF ALL THE SUMMARY PRINTOUTS
C
C*****************************************************************************
C
  500     CONTINUE
          CALL OTSUM2(TIM,ICNT)
          WRITE(6,900)
          WRITE(6,960)
            DO 510 I = 1,ICNT
              WRITE(6,950 ) I
```

```
     *                        , RUNTOT(1)
 510      CONTINUE
        II = CT + 2
        FACTOR = (ICALL - 6) * (60./100.)
C
C       NOW CALCULATE THE PERCENT OF GAME TIME
C       CONDITIONS (X,Y) WERE MET IN OUTSM1(X,Y)
C
        DO 530 I = 1,80
          DO 520 J = 1,II
            OUTSM1(I,J) = OUTSM1(I,J) / FACTOR
 520      CONTINUE
 530    CONTINUE
        WRITE(6,900)
        WRITE(6,940)
        IMAX = CT
        FMT2(3) = ALPH(CT+1)
        WRITE(6,FMT2) ALPH1,(ALPH(JX),JX=1,IMAX)
          DO 550 K = 1,80
              DO 540 M = 1,II
                LINTOT = LINTOT + OUTSM1(K,M)
 540          CONTINUE
            FMT1(3) = ALPH(II)
            N1 = (K * ROF) - ROF
            N2 = (K * ROF)
            WRITE(6,FMT1)
     *                         N1
     *                        ,N2
     *                        ,(OUTSM1(K,I),I=1,II)
     *                        ,LINTOT
            LINTOT = 0.
 550      CONTINUE
          DO 570 I = 1,80
              DO 560 J = 1,II
                PRCNT = PRCNT + OUTSM1(I,J)
 560          CONTINUE
 570      CONTINUE
        WRITE(6,920) PRCNT
        WRITE(6,900)
        WRITE(6,940)
C
        WRITE(6,FMT2)
     *                   ALPH1
     *                  ,(ALPH(JX),JX = 1,IMAX)
        N1 = 0
        N2 = 0
          DO 620 I = 1,80
            ROF1 = OUTSM1(I,1)
              DO 580 J = 2,II
                ROF1 = ROF1 + OUTSM1(I,J)
 580          CONTINUE
C
C             OUTSM2 WILL CONTAIN THE NORMALIZED DISTRIBUTION
C             FOR ROF = I* 50
C
              DO 600 J =1,II
                OUTSM2(J) =0
```

```
                   IF(ROF1 .EQ. 0) GO TO 590
                     OUTSM2(J) = (OUTSM1(I,J) * 100)/ ROF1
  590                CONTINUE
  600            CONTINUE
               FMT1(3) = ALPH(II)
               N1 = (I * ROF) - ROF
               N2 = (I * ROF)
                 DO 610 M = 1,II
                   LINTOT = LINTOT + OUTSM2(M)
  610            CONTINUE
               WRITE(6,FMT1)
     *                        N1
     *                       ,N2
     *                       ,(OUTSM2(J),J=1,II)
     *                       ,LINTOT
               LINTOT = 0.
  620        CONTINUE
           WRITE(6,900)
           WRITE(6,910)
             DO 640 I = 1,80
               II = ROF * I
               JJ = II - ROF
                 IF(ROF3(I) .EQ.0) GO TO 630
                   JACK(I) = (JACK(I) / ROF3(I)) * 3600
  630            CONTINUE
               WRITE(6,930)
     *                       JJ
     *                      ,II
     *                      ,JACK(I)
  640        CONTINUE
           CALL EVENTS(ROF5,MASTIM,ICALL,ROF)
        CALL AVG(IAMP,MASTIM)
C
C
C**********************************************************************
C
C                            F O R M A T S
C
C**********************************************************************
C
C
  900  FORMAT(1H1)
  910  FORMAT(1H1
     *         ,T7,'CONSTANT      NO. OF'/
     *          T7,'RATE OF       RED PUZZLE'/
     *          T7,'EVENTS FOR    EVENTS'/
     *          T7,'1 HOUR                    '//
     *          )
C
  920  FORMAT(T2,'TOT = '
     *         ,F8.4
     *         )
  930  FORMAT(1X
     *         ,I6
     *         ,' -'
     *         ,I6
     *         ,F9.2
```

```
     *          /)
C
  940  FORMAT(T46
     *        ,'R E D   M U Z Z L E   E V E N T S'
     *        ,/)
C
  950  FORMAT(T11
     *        ,I3
     *        ,T17
     *        ,I4
     *        /)
C
  960  FORMAT(T10
     *        ,'MIN     NO.'/
     *        ,T10
     *        ,'OF      OF'/
     *        ,T10
     *        ,'GAME '/
     *        ,T16
     *        ,'TGTS'//
     *        )
C
      RETURN
      END
```

```
      SUBROUTINE GTSUM2(TIM,ICNT)
      INTEGER TIM
       COMMON /   BLK9/MASTIM
     *          / BLK11/IDARAY(240,300)
     *        / BLK10/IDTGT(1000,4)
      LEVEL 2,IDARAY
       DIMENSION IUNEEK(500)
     *          ,ITEM(6,300)
      IF(MASTIM .EQ. 999) GO TO 5000
      IF(ICNT .EQ. 0) ICNT = 1
      ITIM = TIM - 6
      IF( ICNT.NE. NCNT) GO TO 1000
  100 IF (TIM .LT. 6) GO TO 3000
C
C     CHECK THE SIX SECOND WINDOW
C
      DO 500 I = 1,6
C
C      CHECK EACH UNIQUE TARGET
C
      DO 400 J = 1,300
      IF(IDARAY(ITIM+I,J) .EQ. 0) GO TO 450
      DO 300 K = 1,500
C
C      IDTGT CONTAINS A LIST OF UNIQUE TARGETS AND WHETHER
C      THEY HAVE BEEN LOCATED
C
      IF(IDARAY(ITIM+I,J) .NE. IDTGT(K,1)) GO TO 250
      IF (IDTGT(K,2) .NE. 0) GO TO 350
      ITOT = ITOT + 1
      IDTGT(K,2) = 1
       IDTGT(K,4) = MASTIM
      GO TO 350
  250 CONTINUE
  300 CONTINUE
  350 CONTINUE
  400 CONTINUE
  450 CONTINUE
  500 CONTINUE
      RETURN
 1000 CONTINUE
      IUNEEK(ICNT) = ITOT
      ITOT = 0
C
C      STORE THE LAST SIX SECONDS OF THIS MINUTE IN CASE
C      TIM IS LESS THAN SIX ON THE NEXT CALL
C
      DO 1100 I = 1,6
      DO 1100 J = 1,300
 1100 ITEM(I,J) = IDARAY(54+I,J)
      NCNT = ICNT
      RETURN
 3000 CONTINUE
      DO 4000 I = 1,TIM
      DO 4000 J = 1,300
      ITEM(I,J) = IDARAY(I,J)
 4000 CONTINUE
```

```
C
C       SINCE TIM IS LESS THAN SIX ITEM WILL CONTAIN THE SIX SECOND WIN
C
      DO 4500 I = 1,6
      DO 4400 J = 1,300
      IF(ITEM(I,J) .EQ. 0) GO TO 4450
      DO 4300 K = 1,500
      IF(ITEM(I,J) .NE. IDTGT(K,1)) GO TO 4250
      IF(IDTGT(K,2) .NE. 0) GO TO 4350
      ITOT = ITOT +1
      IDTGT(K,2) = 1
       IDTGT(K,4) = MASTIM
      GO TO 4350
 4250 CONTINUE
 4300 CONTINUE
 4350 CONTINUE
 4400 CONTINUE
 4450 CONTINUE
 4500 CONTINUE
      RETURN
 5000 CONTINUE
      WRITE(6,9105)
 9105 FORMAT(1H1)
      WRITE(6,9100)
      DO 6000 I = 1,ICNT
 6000 WRITE (6,9000)  I, IUNEEK(I)
 9000 FORMAT(10X,I3,3X,I4/)
 9100 FORMAT(9X,'MIN    NO.'/
     19X,'OF      OF'/
     29X,'GAME UNIQUE'/
     315X,'TGTS'//)
      END
```

```
      SUBROUTINE UNIQID
      IMPLICIT INTEGER (A-Z)
      COMMON /  BLK1/MISHUN(60)
     *         / BLK10/IDTGT(1000,4)
C
C               IDTGT(I,J) WILL CONTAIN A LIST OF UNIQUE
C               TARGETS (RED MUZZLE EVE
C               IF J=1 THEN THIS TARGET HAS BEEN LOCATED.
C
      CALL TYPE(MISHUN,ITYPE,IFORCE,IRES)
        IF(IFORCE .EQ. 1) GO TO 1400
          IF(MISHUN(3) .EQ. 0) GO TO 1300
            IUNIQ = IRES * 100000000 + MISHUN(6) * 10000 + MISHUN(7)
 1000       CONTINUE
              I = I + 1
              IF(IDTGT(I,1) .NE. 0) GO TO 1200
                IDTGT(I,1) = IUNIQ
                IDTGT(I,3) = MISHUN(2)
 1200         CONTINUE
            IF(IDTGT(I,1) .NE. IUNIQ) GO TO 1000
 1300     CONTINUE
 1400   CONTINUE
      RETURN
     END
```

```
      SUBROUTINE TGTARY(FTT)
       COMMON / BLK1/MISHUN(60)
     *        / BLK11/IDARAY(240,300)
      LEVEL 2,IDARAY
       INTEGER FTT
C
C                 IDARAY CONTAINS A LIST OF TIMES SOUND EVENTS
C                 REACHED THE SOUND BASE (1-240)
C                 AND THE UNIQUE IDENTIFIER (1-300)
C
       CALL TYPE(MISHUN,ITYPE,IFORCE,IRES)
      I = 0
         IUNEEK = IRES * 100000000 + MISHUN(6) * 10000 + MISHUN(7)
         IF(ITYPE .LT. 5) GO TO 1300
           IF(ITYPE .GT. 12 .AND. ITYPE .NE. 15) GO TO 1200
 1000        CONTINUE
               I = I + 1
               IF(IDARAY(FTT,I) .NE. 0) GO TO 1100
                 IDARAY(FTT,I) = IUNEEK
 1100          CONTINUE
             IF(IDARAY(FTT,I) .NE. IUNEEK) GO TO 1000
 1200      CONTINUE
 1300    CONTINUE
      END
```

```
      SUBROUTINE TYPE(MISHUN,ITYPE,IFORCE,IRES)
      DIMENSION MISHUN(60)
      DIMENSION NTYPE(2,40)
C
C          ARRAY NTYPE(I,J) CONTAINS ALL THE WPN TYPES
C
C                         I= 1,2  FORCE NO.
C                         J= 1,40  RESOURCE NO.
C
      DATA (NTYPE(1,J),J=1,40)/
     *         0,   13,    0,    0,   14,    3,    0,    0,    0,    0,
     *         1,    2,   15,    0,    0,    0,    0,    0,    0,   14,
     *        14,    0,    0,    0,    0,    0,    0,    4,    0,    0,
     *         0,    0,    0,    0,    0,    0,   16,    0,    0,    0/
      DATA (NTYPE(2,J),J=1,40)/
     *         0,   10,   11,    0,   11,    5,    0,    0,   11,    0,
     *         6,    7,    6,    0,    0,    0,    0,    0,    0,   11,
     *         6,    7,    0,    0,    0,    0,    0,    9,    0,    0,
     *         0,    0,    0,    0,    0,   12,   16,    0,    0,    0/
C
C     MISHUN(8) IS UNIT ID * 1000 + RESOURCE * 10 + FORCE
C
      IFORCE = MISHUN(8) -((MISHUN(8)/10) * 10)
      IRES   = (MISHUN(8) - ((MISHUN(8)/1000) * 1000))/10
      ID     =  MISHUN(8)/1000
      ITYPE  = NTYPE(IFORCE,IRES)
      RETURN
      END
```

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